STAINLESS STEELS...

for high temperature

Hydraulic Actuators

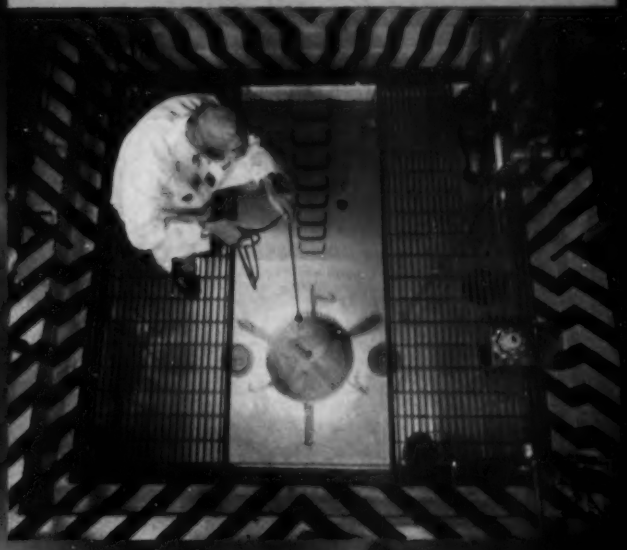
Torque Motors

Irradiated Materials

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

April 1957 FIVE DOLLARS A YEAR



Cobalt-60 takes a self-portrait through 12 ft of water—see page 5

Fuel injector sealed by C/R

ELIMINATES INJECTION NOZZLE LEAKS

Crankcase dilution can be a big headache. But not for one of the leading Diesel manufacturers. They knew that the right injection nozzle seal would cure a major cause . . . and came to C/R Sirvene engineers for help. C/R manufactured this Sirvene (synthetic rubber) part to extremely critical dimensions and physical properties to match the equally precise dimensions of the assembly. Result: no more leakage. When you need a pliable mechanical part compounded to meet critical specifications of heat, pressure, abrasion resistance and molded to the most exacting tolerances, you need C/R Sirvene. C/R Sirvene engineers will gladly cooperate with you in all phases of your sealing problem . . . from design, compounding of the correct oil-resistant elastomers, through laboratory-like control of production quantities. Write for your copy of the new booklet, "Sirvene."

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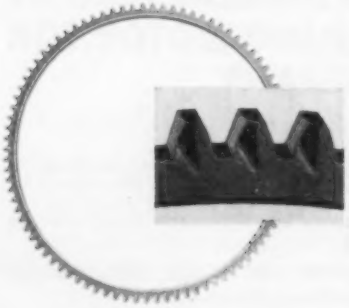
Today's outboards GET GOING with Double Diamond Flywheel Starter Gears



Major makers of electric-starting outboards come to Automotive Gear for their flywheel starter gear requirements. They get our extensive experience in making millions of them for the automotive field—plus skilled engineering aid—plus keen respect for their specifications—plus flame-hardening for better, longer gear performance—plus good delivery.

If you are powering a product, why not talk to the company that specializes in power transmission via gears of many types? An engineer will respond to your inquiry.

EATON

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MANUFACTURING COMPANY
RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

NOTE
LONG, SATISFACTORY PERFORMANCE OF REVERE COPPER AND BRASS PARTS IN THEIR MOTORS LED LELAND ELECTRIC COMPANY TO TAKE ITS ALUMINUM PROBLEMS TO REVERE
LESS MACHINING
Saves on Production Costs
LESS WEIGHT
Saves on Metal

CUTAWAY of the radically new submersible explosion-proof pump motor made by LELAND ELECTRIC COMPANY which can be installed right in the gasoline storage tank. In this pump motor the fluid passes between the stator core and the extruded shell while in the conventional submersible pump motor a double shell is used. Stator shell of the LELAND MOTOR is 13 9/16" long and 3½" O.D. and is made from a hollow Revere Aluminum Extrusion.

REVERE HOLLOW ALUMINUM EXTRUSION USED IN REVOLUTIONARY SUBMERSIBLE PUMP MOTOR FOR LELAND ELECTRIC COMPANY

The original design of this stator shell called for a casting but when the design engineers considered the factors that would be encountered, and the symmetry of shape, it became apparent that an aluminum extrusion might have many advantages over a casting.

At this stage Revere T.A. (Technical Advisory) Service, which in the past had proved helpful, was called in for collaboration and the advantages of extrusions vs. castings were discussed. By using extrusions there would be no problem of porosity which is often present in castings. Substantial savings in weight would be made and the only machining would be to the ribs on the inside of the tube. No machining of the outside of the tube would be required, which would be necessary should a casting be used, while the smoother surface on the inside would improve flow characteristics—an important factor in this particular pump motor as the fluid being pumped passes between the stator core and the extruded shell. With the smooth surface of an extrusion, less horsepower would be used to pump a given volume of fluid. The result was the Revere Aluminum Extrusion you see above.

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

APRIL 1957 Vol. 28, No. 4

High-Temperature Stainless—135... Edward A. Loria
Mechanical properties, structural stability and fabrication of five austenitic and three martensitic alloys.

Medium Vacuum as a Process Tool—140... Ormonde Bogert
Equipment and instrumentation required, some useful formulas and tables.

Torque Motors and Brakes—146... S. Noodleman
Speed-torque characteristics, ratings, frame sizes and variable-voltage controls for braking, clamping, indexing, traversing, and tension.

Design Features in New Products—152...
Lighter weight hydraulic system; electric wristwatch; human-engineered lawn mower; rigid automobile X-frame; weight-controlled vibratory feeder; two-speed press drive; three-temperature refrigerator; self-compensating valve.

More On Surface Finish Inside Tubes—166...
Procedure and maximum average microinch readings inside electrical resistance-welded tubing.

SPECIAL REPORT

New Materials by Irradiation—167... H. I. Raiklin, H. H. Hausner, A. J. Restaino, M. Ference
How metals and plastics are changed by irradiation; data on neutron-bombarded aluminum; graft copolymers by irradiation.

Transient Response of Hydraulic Actuators—175... E. Mucha
Formulas for determining velocity and piston travel of conventional units.

A New Data-Interval Number Series—178... Fred W. Hottenroth
Two numbers, 10 and 32, in a series useful for data on temperature rise, sound dissipation and other logarithmic phenomena.

Woven-wire Conveyor Belts—181... J. F. Reid
Applications, materials, weaves, selvages and cleats, guides and supports.

Second Design Show Doubles In Size—185...
Panel session scheduled on procedure in developing new designs.

Epicyclic Gear Train Calculations Simplified—186... R. M. Conklin, James Ballmer
Step-by-step computations of forces and speeds for compound as well as simple trains.

MECHANISM SPREAD

Gear-shift Arrangements—188... Sigmund Rappaport
Arrangements of gears and clutches to obtain changes in speed ratios.

The Administrative Engineer Can Help—190... Pilson W. Kelly
Smoothing the path for researcher, designer and manager.

More Books (on mathematics)—192... Charles R. Sexton
References received too late for last month's "Engineer's Bookshelf."

When to Use Non-clutch Drives—194... A. F. Gagne, Jr.
Comparisons between methods of transmitting power, including both clutch and non-clutch systems.

REFERENCE BOOK SHEET

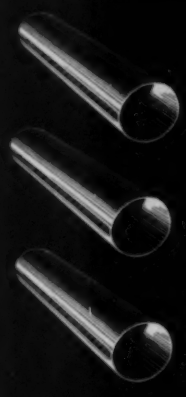
Thickness of Constant-Stress Disks—211... J. H. Rowe
Graphic method that supplants mathematical analysis.

DEPARTMENTS

Interesting to Note	5	Catalogs and Bulletins	361
Developments to Watch	9	Sans, Souci	380
Design Perspectives	129	Engineering Abstracts	387
Editorials	133, 208	New Books	398
Technical News	199	Readers' Letters	411
New Components, Materials	216	Press Previews	417

Three Coated Grades of Armco Steel Tubing

Offer Extra Durability at Low Cost



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THIS MONTH'S COVER

The eerie blue glow in the larger photo is created by Cerenkov radiation—electrons traveling in a transparent medium—here created by 5500 curies of cobalt 60 under 12 ft of water, at the Gamma Facility of the Nuclear Division, Martin Company, Baltimore. For effect of irradiation on properties of materials, see series of articles beginning on page 167.

Interesting to Note . . .

The Day An Age Began

Wednesday, December 2, 1942—a rainy day in New York—but an experimental P-47 *Thunderbolt* reached a speed of 725 mph, thereby setting a new record; a warm day in the Pacific where American subs sank five Japanese ships; a sweltering hot day in North Africa where Allied airpower blasted Tunisia for the twenty-fourth straight hour; and, an historic day in Chicago where a group of scientists opened a door and stepped into the atomic age.

Two teams were working together on the floor of a squash court under the west stands of the University of Chicago's Stagg Field: a group of scientists from Princeton, headed by Dr. S. K. Allison, and a research team from Columbia, led by Dr. Enrico Fermi. The teams weren't there to compete in sports. They were to test a theory of atomic fission and attempt the production of self-perpetuating atomic power.

The first atomic reactor, looking like a squashed orange, was made of graphite and six tons of uranium. Cadmium control rods were cautiously withdrawn. The pile began to hum. Pointers climbed rapidly and for the first time, man duplicated the energy-making process of the sun.

The history of atomic energy didn't begin on that cold December day in Chicago, but man did discover that he could handle a new source of energy. In less than fifteen years, atomic power has become man's newest servant. One such use of this energy is the creation of new and different materials by atomic-particle bombardment. A special report on this aspect of nuclear energy utilization begins on page 167.

Pioneer I—First Stainless Steel Airplane

From the first successful flight of a heavier-than-air ship evolved a conglomeration of planes, all designed to better the original Wright Brothers' invention. Some of these failed miserably; others were improvements. Progress was not only made in the theory of flight, but in the concept of design and use of materials as well.

One of these early planes was the Pioneer I, designed and built in 1932 by the Budd Co., Philadelphia, Pa. For the first time a plane was constructed entirely of stainless steel. The amphibious craft was shipped to Europe where it twice flew over the Alps and demonstrated, in seven European countries, the merits of non-corrosive stainless for airplane construction. In England, the plane crashed and sank in four feet of salt water when an inexperienced

(Continued on page 7)

ABP APRIL, 1957 **Product Engineering** *A McGRAW-HILL PUBLICATION* Vol. 28, No. 4

PRODUCT ENGINEERING is published monthly with an additional Design Digest Issue in Mid-October, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGraw-Hill Building, 330 W 42nd St, New York 36, N. Y. See panel below for directions regarding subscriptions or change in address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. Donald C McGraw, President; Joseph A Gerardi, Executive Vice-President and Treasurer; John J Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B Smith, Vice-President and Editorial Director; Joseph H Allen, Vice-President and Director of Advertising Sales; A R Venezian, Vice-President and Circulation Coordinator.

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United States subscription rate for individuals in the field of the publication, $5.00 per year, single copies, one dollar. Second-class mail privileges authorized at Albany, N. Y., U.S.A.

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PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index.** PRODUCT ENGINEERING publishes its own annual index including the Design Digest issue in December issue each year. Copies are obtainable on request to the Editor.

SUBSCRIPTIONS. Send subscription correspondence and change of address to Subscription Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Subscription Manager promptly of any change of address giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Please allow one month for change to become effective.

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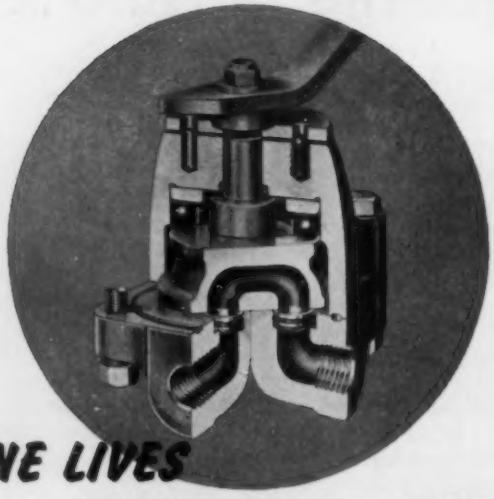

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	They give quick action of full flow through round tubular flow passages	No spools or poppets obstructing flow
to provide unmatched control of oil hydraulic cylinders, presses and motors	Excellent throttling	Smooth action to any degree of flow without fighting the fluid pressure
	Quick opening & closing with surge dampening action	A quarter turn of the handle opens full round flow passages without surges caused by slamming spools or poppets
	Simplified Maintenance	By removing four bolts and without touching the plumbing all valve parts are easily accessible for replacement or service (seldom needed)

* Over three million cycles, without signs of efficiency loss, were clocked for 4-Way valves on a machine making high pressure impulse tests of aircraft hose. Another group of 24 Dual pressure valves has been operating since 1951 for 22 hours a day, five days a week, on presses making rubber casters and wheels and they are still sealing tight with practically no maintenance.

We'll be glad to refer to you similar examples in your own vicinity. To get complete data on Shut-off, 4-Way and Dual pressure Valves for oil pressures to 1500, 3000 and 6000 P.S.I. ask for bulletins 0-5 and 5-DP.

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BY A MERE COIL CHANGE

Crescent® Valves are adaptable to

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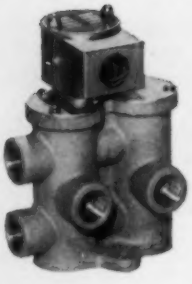
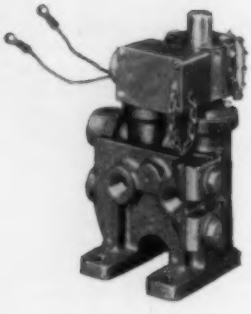
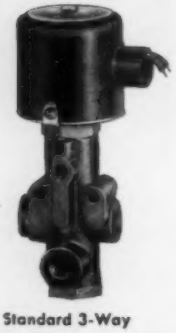


Standard 4-Way



J.I.C. Type 4-Way



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® 4-Way and 3-Way Solenoid operated, pilot controlled valves for Air, Water and light oil to 150 P.S.I., products of Crescent Valve Co.

NO COIL BURNOUT

because a generous power margin, short solenoid travel and pilot operation combine to prevent overheating and overloading. Note that these valves are accepted and used in automotive plants where assembly line production does not permit coil or valve failure.

LONG SERVICE LIFE

Main valve design is aimed at extremely long trouble free service. Resilient seats are tight sealing and are not affected or damaged by dirt or grit because they are of a self scavenging design. Witness their superior performance in such severe service as operating hopper doors on cement batching equipment and in other dusty environment.

INTERCHANGEABILITY

Solenoids and pilot sections are interchangeable from one valve size to another, minimizing spare parts requirements. Adaptation to any practical voltage is achieved by a simple coil change.

Speed of response, speed of installation and dependable leakproof operation year in and year out are responsible for the increasing switch to Crescent valves on production machinery where time is money.

For complete data write for Catalog 6-C.

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

Interesting to Note . . . .

pilot misjudged his distance on a glassy bay. It remained submerged for several days, after which it was withdrawn and repaired with no damage to the metal as a result of submersion in the salt water.

Stainless steel was but one of many materials used experimentally in early aircraft design; aluminum alloys followed and have been the most common structural materials. In today's age of supersonic speeds, materials have to be considered not only in relation to their weight but to their resistance to temperatures as well. Titanium alloys and certain stainless steels are designed specifically for these conditions. An article discussing High-Temperature Stainless Steel appears on page 135.

Burndy Library

The Lightning That Failed

When Benjamin Franklin performed his famous kite and key experiment with lightning, he was setting the groundwork for deeper study into the properties of electricity. At the request of French king Louis XV, physicists Dalibard and Delor repeated Franklin's experiments before a fascinated court. However, not all attempts to handle lightning ended successfully. In 1753, Swedish physicist Georg Richmann attempted to repeat an experiment of Dalibard. While working with ungrounded equipment, his apparatus was struck by lightning. A spark nearly a foot long jumped from an insulated rod to his head—he was killed instantly. Also struck but not killed was his companion Soklov.

Electricity still mystifies many, but it has proved to be a most successful source of power throughout the world. Electric motors have given us one such means of handling this power. Although most electric motors drive rotating shafts and wheels, many tasks to be performed in machines are accomplished by the limited movement of a cam or lever. For these tasks, the torque motor can be called upon. An article discussing torque motors begins on page 146.

An Image of Eternity

"Time was created as an image of eternity," said Plato. Yet only during the past several hundred years has man learned how to measure accurately this "image of eternity." Timekeeping has come a long way since man kept track of the hours by observing natural actions of known duration: the movement of the sun, moon and stars; consumption of certain materials by fire; and the flow of water and sand.

One of the early problems of telling time was finding a way to record the seasons. A gnomon, or shadow stick, was used. This stick, inserted vertically in the ground, threw a shadow that was measured daily. The minimum length of the shadow (noon) grew shorter or longer, according to the phase of the sun. In latitudes near the equator, the maximum or minimum shadow was used as a check-point to determine seasons so that planting could be regulated.

Accuracy in timekeeping has progressed from this primitive method, (which is still employed by the Dyaks of Borneo) so that an electric wristwatch of today can record time with an accuracy said to be 99.995%. Design features of this new timepiece, that operates without a mainspring, are described on page 156.

Problem for Two Engineers

Two young graduates stood before the desk of the Jewel Bearing Company's chief engineer. Both had recently acquired ME degrees; both were equally qualified for the job being offered. The chief engineer could choose but one. He decided to give them both this problem:

"Gentlemen, throw away all you have been told about engineering; use only logic and your common sense. Here are one hundred boxes of our ball bearings. Each box contains one hundred balls; each ball weighs one ounce; each box weighs one ounce. All hundred balls in one box are either ten per cent heavier or ten per cent lighter than an ounce, yet their outward appearance is the same as the balls in the other boxes. Here is a very sensitive spring scale. Gentlemen, you may make but one weighing. Tell me, from it, which box contains the out-weight balls—and whether they are heavier or lighter. Placing all the boxes on the scale and removing them one by one isn't cricket, as you're taking multiple readings. Remember, use only logic; no other device is necessary . . . good luck."

The solution to this problem will appear next month. However, in this issue on page 178 is an article discussing a Preferred Number Series. This article won't help the two engineers, but it may help you.

Mallory Motor Starting Capacitors
give Years of Trouble Free Service

Ask the engineers who design motors—ask those who build them—ask the men who design motors into equipment assemblies—or ask the service engineers . . . they can all tell you that Mallory motor starting capacitors are tops for any job.

Mallory is the world's largest manufacturer of these capacitors. Their reputation in the motor field has been built on delivering years of trouble-free service—the kind that saves their customers the expense and embarrassment of field failures. Mallory capacitors offer longer operating life—indefinite shelf life — precise capacity for high-torque starting and cut-out timing—and rugged, plastic-cased, moistureproof construction.

Mallory offers these motor starting capacitors in a broad range of standard types. If your problem is one of special requirements, call on Mallory's engineering design service for assistance.

Like to have a copy of Mallory's booklet—"Electrolytic Motor Starting Capacitors"? It contains a complete appraisal of the construction and application of motor starting capacitors. Write, or ask the Mallory representative for a copy of Bulletin 4-21.—It's free.

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
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Developments

To Watch

A CERAMIC HONEYCOMB SANDWICH . . . .

. . . . capable of withstanding 2000 F in repeated heats, has a strength of 25,000 to 30,000 psi in compression and weighs 2-2½ lb per sq ft for a sandwich 1-1½ in. thick. Strength of the material is about 375,000 psi still in the laboratory stage at Continental Can Co., 100 East 42nd St., New York 17, N. Y., the ceramic sandwich is an outgrowth of a project to develop an asbestos honeycomb for firewalls. The asbestos honeycomb is bonded with an inorganic cement to CA asbestos board. This will stand 1700 F for 40 min, and is expected to take 2200 F when development is complete. With the ceramic sandwich, a long-fiber asbestos paper, formed as a square or hex honeycomb core, is dipped in alumina. The skins, similarly made, are attached and the assembly is fired at 3000 F. This burns out all of the asbestos and paper except the long fiber, leaving a double wall whose total thickness is 0.020 in. Any forming and hole cutting cannot be done after the sandwich is fired, nor can it be cut with anything except a diamond tool. Tolerances can be held to about ±0.005 in. The sandwich made thus far softens just over 3000 F, but still will take temperatures much higher than materials presently available. One expected application: missile nose.

ACCURATE ELECTRICAL CURRENT MEASUREMENT . . . .

. . . . is possible with a method that is unaffected by voltage or frequency. Using a light beam as a link between the high voltage conductor and the pick-up unit, the current to be measured modulates the light beam, and in this modulated form is displayed on a photo-cell. A recording instrument measures the voltage across the load resistance of the photo-cell. The rotation of the plane of polarization by a magnetic field, which is used to modulate the light beam, is known as the Faraday effect. Consequently, the complete measuring device consists of a light source, a polarizer, a modulator, a condenser and an analyzer. The amount of light passed through is picked up by a photo-electric amplifier. One modulator consists of a system of reflecting prisms attached to the high voltage conductor. The light beam thus travels some distance in the magnetic field with a minimum of inductive reactance in the measuring system, as the Faraday effect does not depend on the direction of the light. A stabilized high pressure mercury lamp should be used as the light source. Frequency response between 0 and 680 kilocycles per sec is perfectly linear. The new device was developed at the All-Union Electrical Engineering Institute in Leningrad, Russia.

AUTOMOTIVE GAS TURBINE WILL BE OPTIONAL EQUIPMENT . . . .

. . . . on Chevrolet trucks in 18 months or less, according to the best guesses in the Detroit area. In three to four years the gas turbine should be a standard item. Just recently the Chevrolet Div. of General Motors Research staff announced the Turbo-Titan, a 200 hp gas turbine powered truck with a regenerator reported to recover 80 per cent of the heat. (Chrysler claims a 90 per cent heat recovery for their gas turbine.) The engine weighs about 850 lb, including the accessories, and generates 200 hp at 35,000 rpm gasifier speed. The power turbine speed is 28,000 rpm and idles at 15,000 rpm. Maximum gas temperature is 1650 F. The

(*Continued on page 10*)

compressor operates at a pressure ratio of 3.5 to 1. The regenerator is a metal mesh drum driven at 20 to 30 rpm. Both turbine wheels are single-stage axial flow type; compressor is a single-stage centrifugal type. An electric starter brings the gasifier up to 4000 rpm at which time the fuel is turned on.

HIGH TEMPERATURE NICKEL ALLOY . . . .

. . . . called Incoloy "T" is expected to find future application in airframe parts of planes to be used for hypersonic flight at speeds found at the thermal barrier. Produced as a strong sheet material designed to operate at temperatures up to 1400 F, and in some applications even higher, the titanium-containing nickel-iron-chromium alloy is similar in composition to Incoloy and contains one per cent titanium. Incoloy T alloy is reported to have good oxidation resistance at temperatures up to 1600 F. Cyclic oxidation tests conducted at 1600 F for from 100-1000 hr showed that the change in weight was the same for both alloys. The Incoloy T sheets as produced are annealed at 1900-1950 F. Some fabricators claim good formability and strength by process annealing components at 1800-1850 F for 20-30 min. followed by rapid air cooling. The alloy was developed by the International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

COURT RULES FOR PROFESSIONAL ENGINEERS . . . .

. . . . stating that professional employees under the Taft-Hartley Act have a right to vote on union representation without any non-professionals in the voting unit. The decision follows the National Labor Relations Board's action which places nine non-professional employees in a voting unit with 233 engineers found to be within the professional category at the Buffalo plant of Westinghouse. The NLRB claimed it could do this under its "predominantly professional" theory, even though the Taft-Hartley Act specifically forbids an involuntary mixture of professional and non-professional employees.

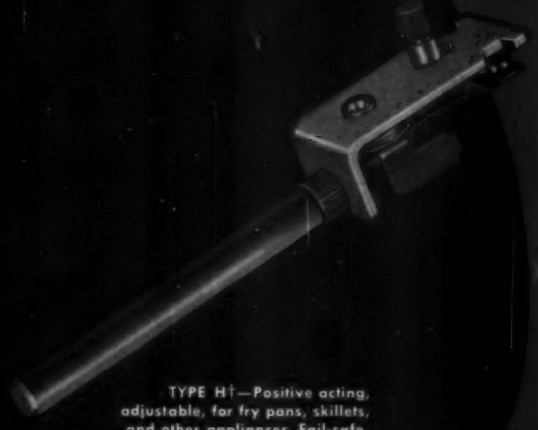
GERMAN COMPANY WILL MAKE AIRCRAFT ENGINES . . . .

. . . . for Curtiss-Wright Corp. if present negotiations jell, according to reports. In return, Daimler-Benz cars, of Stuttgart, Germany, manufacturers of the Mercedes-Benz cars, will give Curtiss-Wright (and Studebaker-Packard) distribution rights in this country to all of the Mercedes-Benz cars, plus automotive styling and engine design aids. Also, Studebaker-Packard will ultimately make (manufacture or assemble) Mercedes-Benz marine engines and a tractor truck called the Unimog. The deal is not being held up by fuel injection system arrangements as was previously reported. The fuel injection system is a product of the Robert Bosch Co. of Germany.

DRY POWDER SELF-FLUXING BRAZING ALLOY . . . .

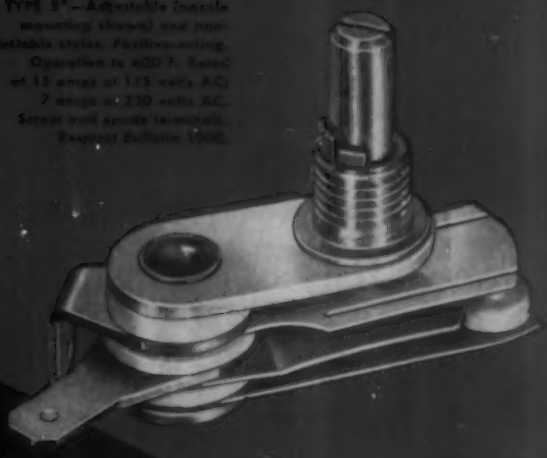
. . . . which is applied as an aqueous slurry, can be applied to any surface regardless of its contour. Assemblies can be brazed where the shape or location of the joint make it impractical to use preforms or to hand feed solid brazing alloys. The alloy will not flow prematurely and will wet only those surfaces to which it is supplied. Made by Handy & Harman, 82 Fulton St., New York 38, N. Y., the alloy is an aluminum-silicon eutectic (88% aluminum, 12% silicon) and melts at 1070-1080 F and carries the AWS designation BALSi-4. The brazing alloy has its own fluxing material which serves both as a flux and as a cement to keep the alloy in place during the brazing cycle. When the slurry is dried after application,

(*Continued on page 12*)



TYPE H†—Positive acting, adjustable, for fry pans, skillets, and other appliances. Fail-safe, open in low to 500°F in high. Rated at 1650 watts at 115 volts AC. See Bulletin 10,000.

TYPE S*—Adjustable (metric mounting shown) and non-adjustable styles. Positive-acting. Operation to 400°F. Rated at 15 amps at 115 volts AC; 7 amps at 230 volts AC. Screw and spade terminals. Request Bulletin 1000.



STEMCO THERMOSTATS

give you more of what you want most

TYPE SA*—Adjustable (shown) and non-adjustable. Snap acting with electrically independent bimetal. Also single-pole, double-throw. Non-inductive-load rating 15 amps at 115 volts AC; 10 amps at 230 volts AC. Spade or screw terminals. Request Bulletin 2000.

TYPE A*—Semi-enclosed. Insulated, electrically independent bimetal disc gives fast response and quick, snap-action control. Operation from −10° to 400°F, or higher on special order. Various mountings and terminals. Rated at 6½ amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. See Bulletin 3000.

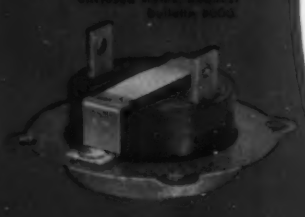
Features such as snap or positive-action . . . various terminal arrangements or mounting provisions . . . different temperature ranges—there's a *standard* type Stemco thermostat for your *special* needs. That means you cut down on lead time, research and development costs, tooling and production inventory. Specify Stemco and you get *better thermostats, faster and for less* than you can make them or buy them elsewhere.

Size and weight are particularly important in appliance and apparatus applications. And here Stemco thermostats score, too. Their compactness and lightness give a better product without sacrificing performance.

Economy of mass production of many standard Stemco types with literally hundreds of terminal arrangements and mounting provisions means your product costs less to make, is easier to sell.

Availability of most types is good. Design is flexible for your special applications, tooling is in existence for short-term delivery. If heat control is your problem, Stemco thermostats can provide the answer.

AA-3761



*Refer to Guide 400 E0 for U. L. and C.S.A. approval ratings.

Patent Applied For

STEMCO THERMOSTATS

STEVENS manufacturing company, inc.

Lexington and Mansfield, Ohio

the flux forms a cement which does not melt at the usual brazing temperatures, but which is soluble in the salt. Designed for use in a molten salt bath, the alloy will join aluminum alloys: 25, 35, 525, 615, 625, 635, 665, and several types of casting alloys.

ENGINEERS' OPPOSITION TO UNIONS . . . .

. . . ., as the best method to resolve the problems of professional engineering employees, was confirmed in a recent survey by the Industrial Relations News. All engineering fields were surveyed but the weight of the sample was on electrical engineers employed in companies with 1000-3000 employees in Northeastern and Midwestern United States. About 50% of those in the 21-30 year age group felt that they were a part of management. About 75% in the 31-35 year group felt a part of management, and 80% above that age. At least 75% of all engineers surveyed said their individual economic interests could best be advanced through individual initiative. Only 5% felt that an engineering union could best advance their economic interests; 20% favored a professional, nonbargaining group.

OIL-FREE BEARING MATERIALS . . . .

. . . . for possible use in clocks and instruments used in aircraft are being investigated by the National Bureau of Standards, Washington 25, D. C. Required operating range is —76 to 167 F. Wear test data from polytetrafluoroethylene (PTFE) showed that this material without fillers is not suitable for general use. The increase in friction below —4 F detracts from its usefulness at these temperatures. The high friction of polytrifluorochloroethylene (PTFCE) at ordinary temperatures and rate of wear prohibits its use as an oil-free bearing material. There is a reduction of friction with a decrease in temperature. The most promising material developed in PTFCE with a 10 to 60% filler of PTFE. This material has some of the hardness characteristics of PTFCE, the frictional characteristics of PTFE and a wear resistance much greater than either of these plastics alone. One poor quality is its poor frictional characteristics below —4 F. Also showing promise is PTFE with a molybdenum metal powder as a filler.

AND IN ADDITION . . . .

. . . . A solar energy converter panel capable of developing 25 watts of electrical power has been demonstrated by Hoffman Electronics Corp. of Los Angeles; the silicon cells can convert 10% of the energy of the sun into its usable electricity. . . . United International Research, Inc., 38-15 30th St., Long Island City 1, N. Y., claims to have the purest titanium powder on the market; oxygen content in —100 mesh powder is as low as 0.034 per cent. . . . National Research Corp., of Cambridge, Mass., has a new vacuum process for the production of highly reflective metallic coatings on rolls of plastic film, fabrics, and ultimately paper. . . . As an indication of the size of future commercial air transportation, the CAA predicts by 1970 118-million passengers a year will be traveling on domestic airlines, compared with 42-million in 1956. . . . Bell Telephone Labs., New York 14, N. Y., has reported the successful operation of a solid-state device which will oscillate a microwave frequency. The device which might be called a spin oscillator, will also operate in principle, as an amplifier. It is expected to have very low noise compared with conventional microwave devices. A crystal containing a small amount of paramagnetic salt produced continuous oscillations at 9000 megacycles. . . . A cost cutting extruded semi-rigid vinyl insulated wire which will eliminate the necessity of nylon jacketing or textile overbraiding has been announced by the William Brand & Co., Inc., Willimantic, Conn.

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TOUGH THERMOSTATS SAY "RELAYS FOR SISSIES"

Snap-Action Thermoswitch Units Boss Big Loads Without 'Em

"Relays? Who needs 'em?"

ASHLAND, MASS. — If you want to control good-size electrical loads with a precision thermostat, and you don't want to bother with relays, Fenwal has just the thing.

Fenwal has two series of snap-action Thermoswitch® units, more than twelve models, all based on the same idea — and they don't need relays.

The idea is this:

A liquid responds to temperature changes by expanding or contracting, and moves a bellows assembly. The bellows assembly works a snap-switch with a push-rod, making or breaking a circuit.

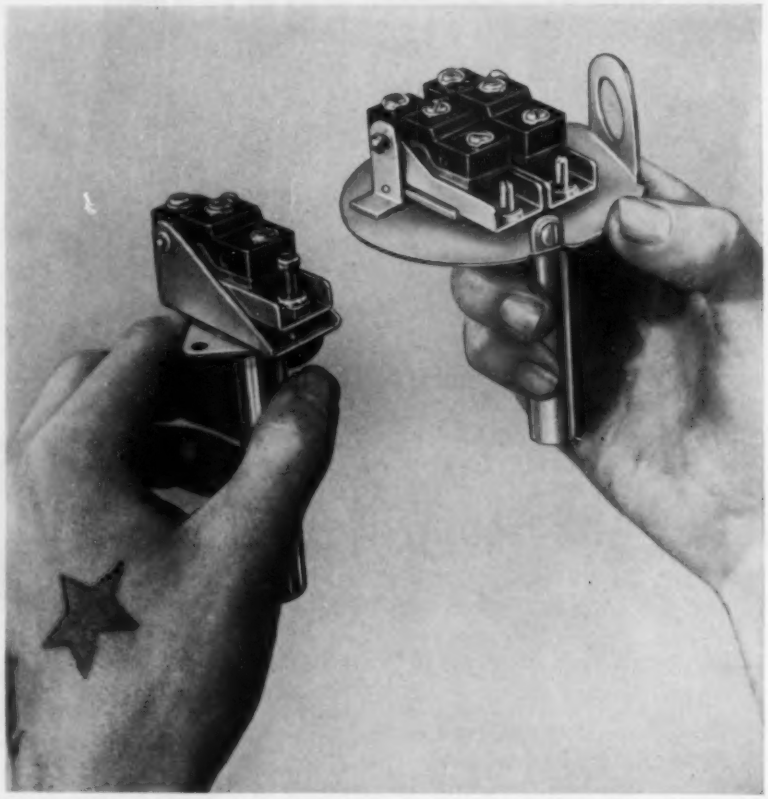
This arrangement will let you control electrical loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts, D.C., without relays, and with a high degree of accuracy.

Fenwal's two series of these remarkable units are called the 20000 and the 22000. The first has only one snap-switch, and the second has two. Two snap-switches and one unit, of course, give you compact control for two-stage heating or cooling.

As for adjusting temperatures — your own men can do it simply in the field. An easy-to-get-at set screw on each switch does the trick. On the double switch models, each switch is set independently.

As for accuracy and speed of response — the units control to within ±2° F.

As for cost — Fenwal has designed both series of snap-action THERMOSWITCH controls along "building block" lines to save you money. That is, Fenwal can assemble specialized units for you from a selection of standardized temperature ranges, head types, "application-rated" snap-switches, and mounting styles.



THESE TWO FENWAL SNAP-ACTION THERMOSWITCH UNITS — control loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts D.C. — without relays. These are only two of the twelve models available from Fenwal's Series 20000 (one-switch) and Series 22000 (two-switch) snap-action units.

The temperature ranges you can choose extend from −75°F. to +300°F.

If you choose these controls for your application, you will not be choosing an untried product. You will be joining a large group of satisfied users who have put them to work in such varied equipment as air conditioners, hot-drink vending machines, laundry equipment, and dishwashers.

Designers — write for details on the Fenwal Series 20000 and 22000 snap-action THERMOSWITCH units. You will want those details at your fingertips. Write to **Fenwal Incorporated, 25 Pleasant Street, Ashland, Massachusetts.**

Fenwal

CONTROLS TEMPERATURE ...PRECISELY

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LINK-BELT Motogear designed for bracket-mounting foot-type motors of any manufacturer

Immediately available from stocks near you—new Link-Belt Motogears in sizes up to 60 hp, output speeds from 280 down to 6 rpm.

Wherever space is restricted . . . where downtime means a costly break in production continuity—Link-Belt Motogears soon pay their own way. In addition to easy motor replacement—simplified ratio changes and quick accessibility of parts for maintenance offer major service savings.

Contact your nearby Link-Belt office or authorized stock-carrying distributor for facts. Ask, too, about the new flange-mounted Gearmotors stocked in sizes up to 30 hp. Or write for Book 2447, giving details of both.

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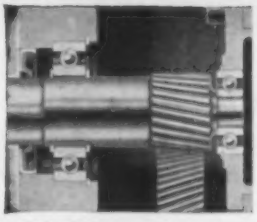
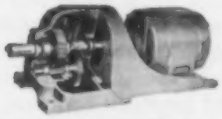
EASY MOTOR REPLACEMENT—Remove four mounting bolts and separate coupling. Oil drainage is unnecessary. Sturdy bracket design aids motor re-alignment.

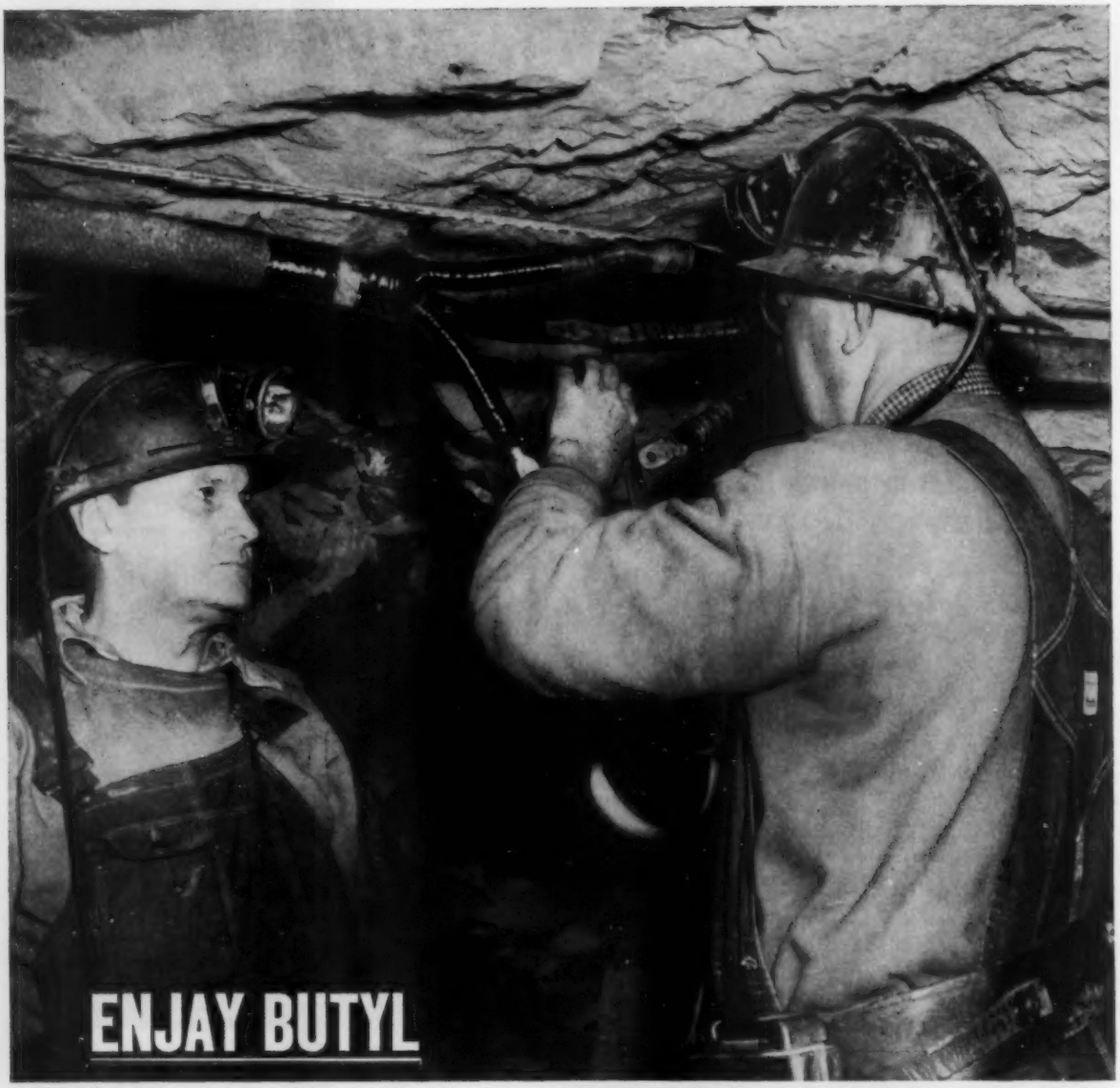
ABILITY TO ACCOMMODATE A WIDE RANGE OF MOTORS meets emergencies, minimizes downtime.



RIGIDITY of high-speed shaft and pinion is provided by straddle-mounting — extremely important in coping with shock, reversing or heavy loads.



ONE LOW-SPEED GEAR SET per drive size and maximum accessibility of all operating parts simplify inspection, maintenance and ratio changes.



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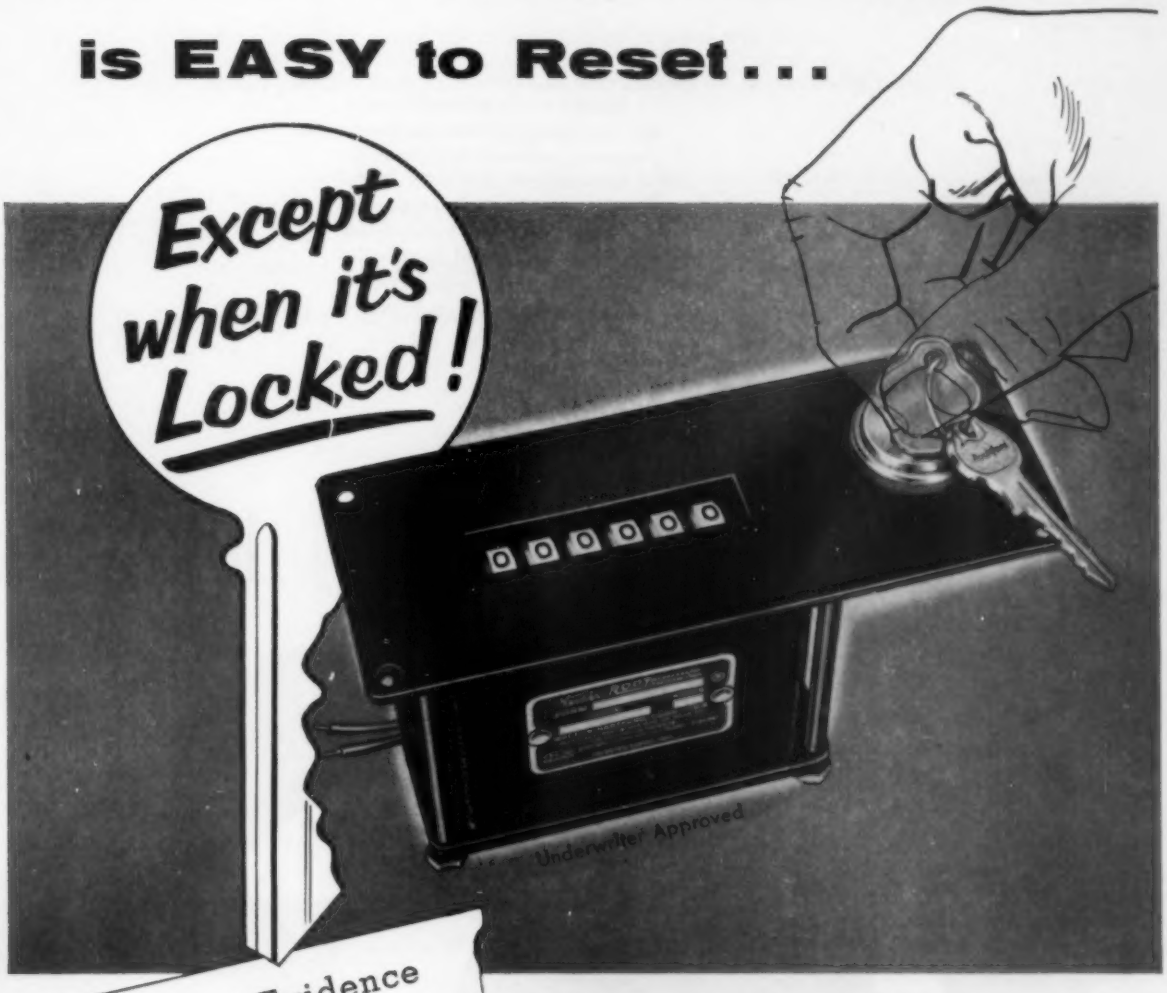
This NEW Magnetic Counter is EASY to Reset...



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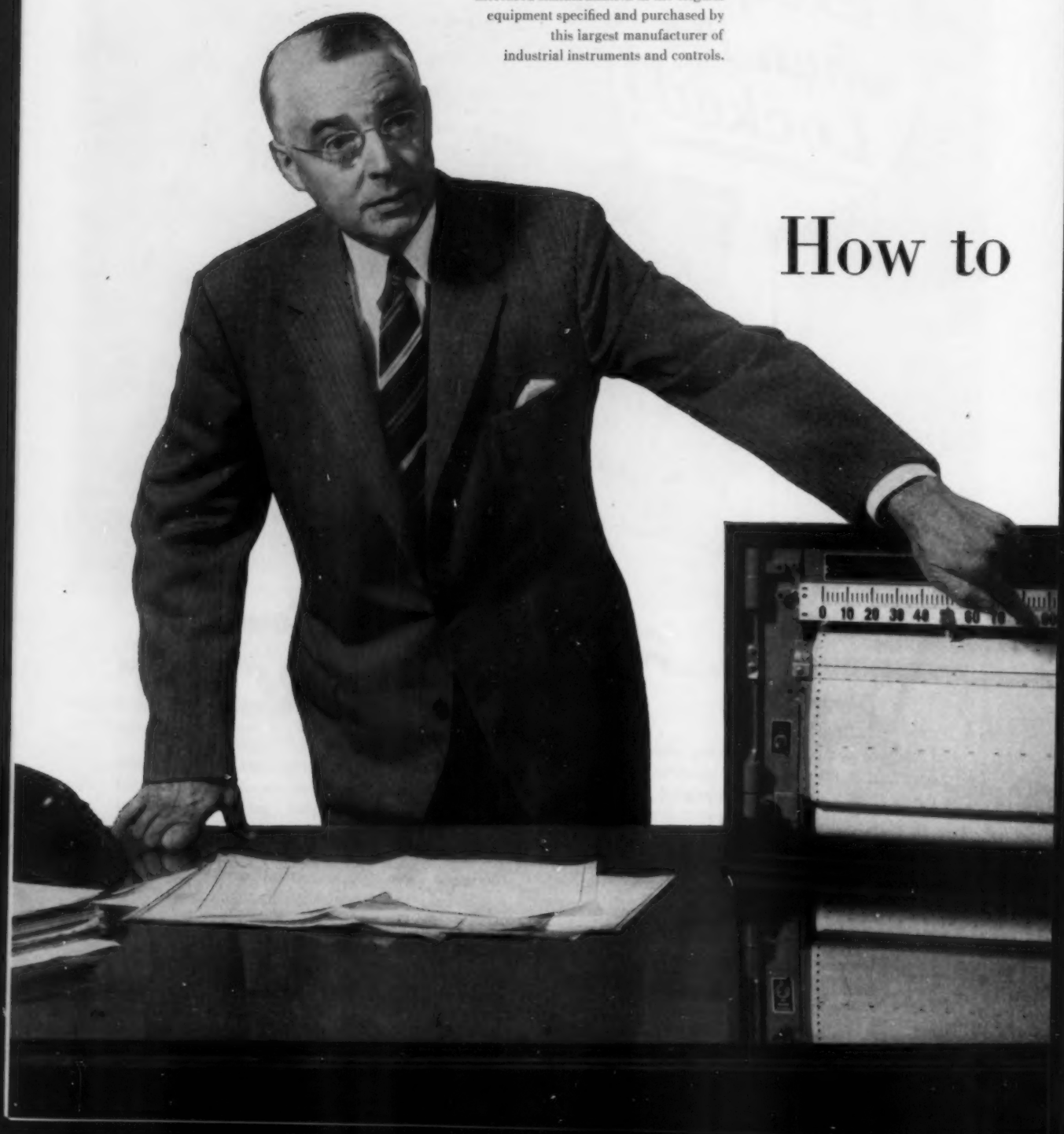
In addition to his responsibilities for the design drafting of Brown indicators, recorders, and electric and pneumatic control instruments, Mr. Karl Maier devotes much time to the development of increased standardization in the original equipment specified and purchased by this largest manufacturer of industrial instruments and controls.

How to



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Karl L. Maier, *Chief Draftsman*
Brown Instrument Division, Minneapolis-Honeywell Regulator Co.
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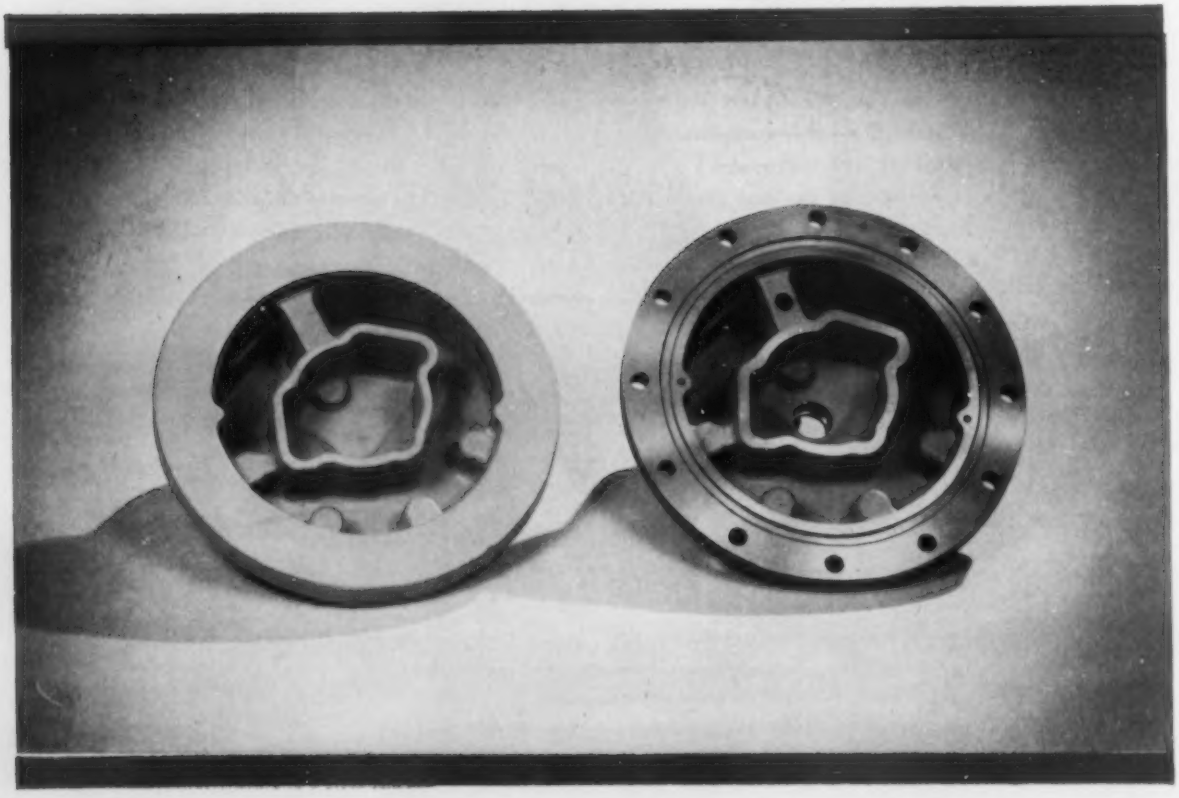
How shell castings + ArmaSteel

This compressor head casting for an air conditioning unit produced by Central Foundry Division is a good example of the improvements and savings so often realized when ArmaSteel and shell castings are combined. This part is subjected to high chamber pressures and must be free of vapor leaks. ArmaSteel has the ideal physical properties for this job including good machinability.

The shell casting process supplies clean, sand-free casting surfaces and greater dimensional uniformity which eliminates costly machining in the chamber, on the O.D. and profile milling on the contour. Thus, by using the shell casting process together with ArmaSteel in this part, material is saved, machining is saved, scrap losses are reduced 80%, and . . . due to ArmaSteel's high physical properties . . . a greatly improved product results.



= savings for you

Here are two more parts improved by shell casting. The Crankshaft Sprocket was formerly machined from bar stock on automatic screw machines. By the use of shell castings on automatic chucking machines, material and machining were saved and a product with greater performance resulted.

Rocker Arms are a typical example where the uniformity of shell castings has made the part more adaptable to automatic machining. Preliminary grinding on pad ends has been eliminated, leaving only a finish grind. Center hole is cast with a minimum of finish stock eliminating a preliminary drilling operation.

In **SHELL CASTING** the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages:

- **Greater uniformity**
- **Closer tolerances . . . reduced finish allowances**
- **Greater accuracy which makes intricate designs possible**
- **Improved casting surfaces**
- **Freedom from residual sand**
- **Less excess metal resulting in lower freight charges**
- **Longer tool life**

ARMASTEEL is an arrested malleable iron of pearlitic structure. The size and arrangement of carbon nodules in this pearlite result in a freely machining material that has the strength and performance characteristics usually associated with carbon steel forgings. Thus ArmaSteel offers you:

- **Uniform structure**
- **Good machinability**
- **Excellent bearing properties**
- **Good wear resistance under heavy loads at high speeds**
- **Long fatigue life, high yield strength, maximum rigidity**
- **Good damping capacity**
- **Adaptability to selective hardening**

For further information about shell or sand castings, ArmaSteel, malleable iron or grey iron castings, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

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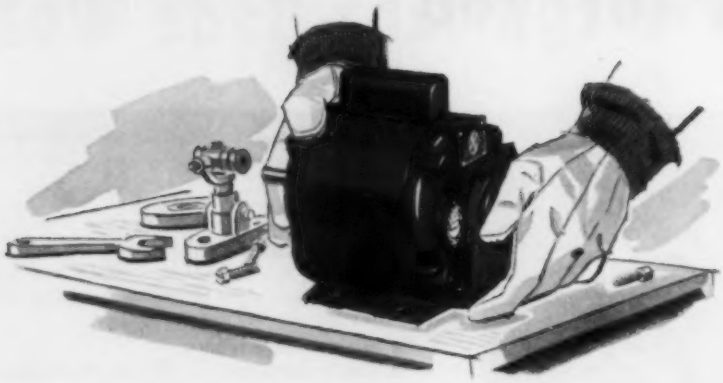
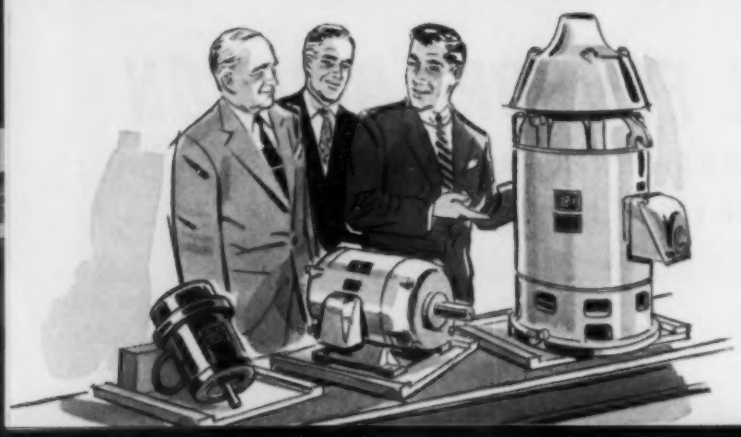
some want 'em small



some want 'em

big

some want 'em in between



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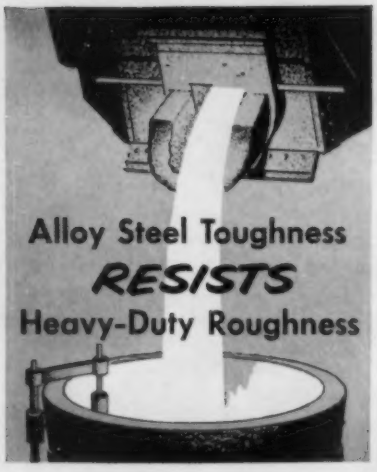


Landing-gear strut for the North American F-100C is manufactured by Bendix Products Division, Bendix Aviation Corporation. Exacting requirements for inner and outer cylinders resulted in the development of a new grade of steel by Bendix and Republic metallurgists working in cooperation with North American engineers.

How Metallurgical Teamwork Developed the Super Sabre's Tough,

When a new grade of steel is born, there's sure to be an interesting story behind it.

In this case, it's the story of close cooperation between metallurgical teams from Bendix and Republic. Their common goal: development of a tough, strong, alloy steel to withstand the shock, impact, strain and vibration of tons of aircraft hitting the runway at speeds in excess of 100 miles per hour.

It starts after World War II, when Bendix metallurgists undertook a program to correct certain characteristics and improve processing deficiencies of steels commonly used for aircraft landing gear.

Several leading steel companies, including Republic, were consulted and the program outlined. Republic immediately put its 3-Dimension Metallurgical Service Team on the problem.

The field metallurgist worked closely with Bendix metallurgists and engineers right in their own plant under actual operating conditions. Their findings were supplemented and coordinated by the other two members of the Republic team—the laboratory and mill metallurgists.

The result: development of a new grade of steel that

REPUBLIC

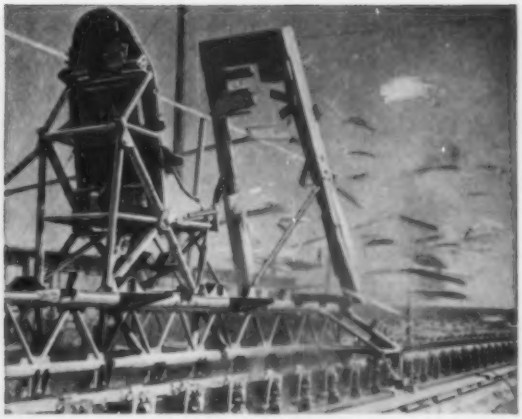
REPUBLIC STEEL

World's Widest Range of Standard Steels

Strong, Alloy Steel Landing Gear

was found ideal for application in the strength range of 220,000-240,000 psi. This steel, designated AMS 6427 by the SAE, offers maximum resistance to fatigue. Provides an exceptionally high strength-to-weight ratio. Maintains its great strength at wide temperature extremes. Responds uniformly to heat-treatment, producing hard, wear-resistant surfaces around tough cores.

Are you sure you are using the right steel? Why not make sure by using Republic's 3-D Metallurgical Service to assist you in a check-up? It's confidential. There's no obligation. Just send us the coupon.



WHERE STRENGTH IS AN IMPORTANT REQUIREMENT—such as this rocket sled for deceleration tests—manufacturers choose tubing for basic construction. At any given weight, tubing is strongest of all mechanical shapes . . . as a beam . . . in torsion . . . under compressive loads. Republic ELECTRUNITE® Steel Mechanical Tubing, the original electric resistance welded tube is well known for quality and performance. It's available in carbon and stainless steel in a wide variety of sizes, shapes and gages. Send coupon for more facts.

HIGH STRENGTH AND LIGHTWEIGHT ADVANTAGES of Republic Titanium are adding range, speed and maneuverability to both military and commercial aircraft. In the Navy's HOK-1, sections fabricated from Republic Titanium, Type RS-70 Annealed are used as the firewall between pilot and engine compartments. But, titanium should not be looked upon as strictly an aircraft or military metal. Its extremely high resistance to most forms of corrosion makes it attractive for use in processing and chemical equipment, heat exchangers, dehydration trays, anodizing racks, etc. Mail coupon for more information.

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Hyatt's Simplified Fitting Practice for Bearing Races

HYATT pioneered the use of carburizing type alloys in order to obtain the advantages of heavier race fits

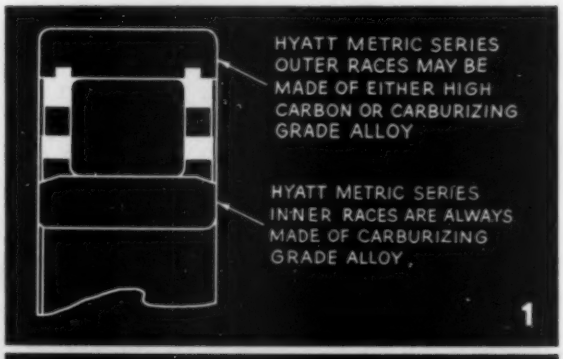
To obtain the best possible performance, roller bearing races must be assembled on shafts and in housings with certain fits developed by design and experience. The most frequent condition to be met is a rotating shaft where specific load and speed conditions must be satisfied with appropriate race fits. These vary according to the manufacturer, and in the case of some manufacturers, according to the application. Naturally, the fits will also vary according to bearing type and size.

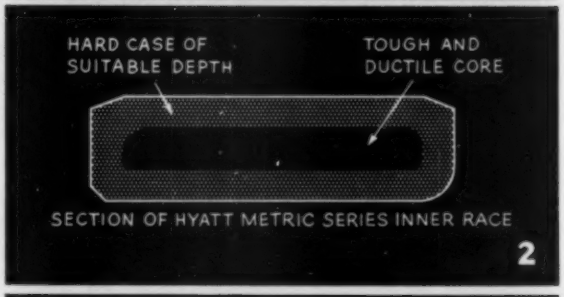
1. CARBURIZING PERMITS HEAVIER INTERFERENCE FITS

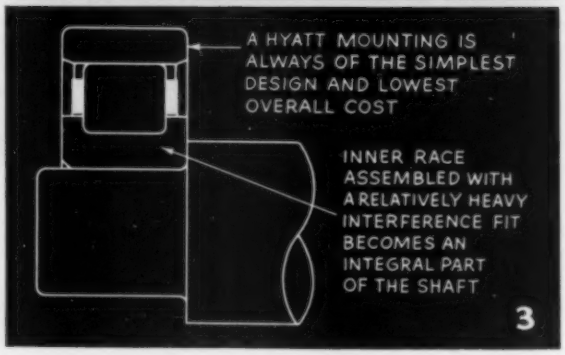
Taking the standard metric series of cylindrical roller bearings for an example, the bearing user has the choice of two fitting practices. One involves the use of inner races made of through-hardening steel, which dictates fairly light interference fits to avoid splitting. The other utilizes races made of low carbon steel *carburized* and hardened to develop a suitable surface hardness and a tough ductile core. The latter permits much heavier interference fits and has the additional advantage of eliminating all auxiliary holding devices, because the race becomes practically an integral part of the shaft. (Figs. 1, 2.)

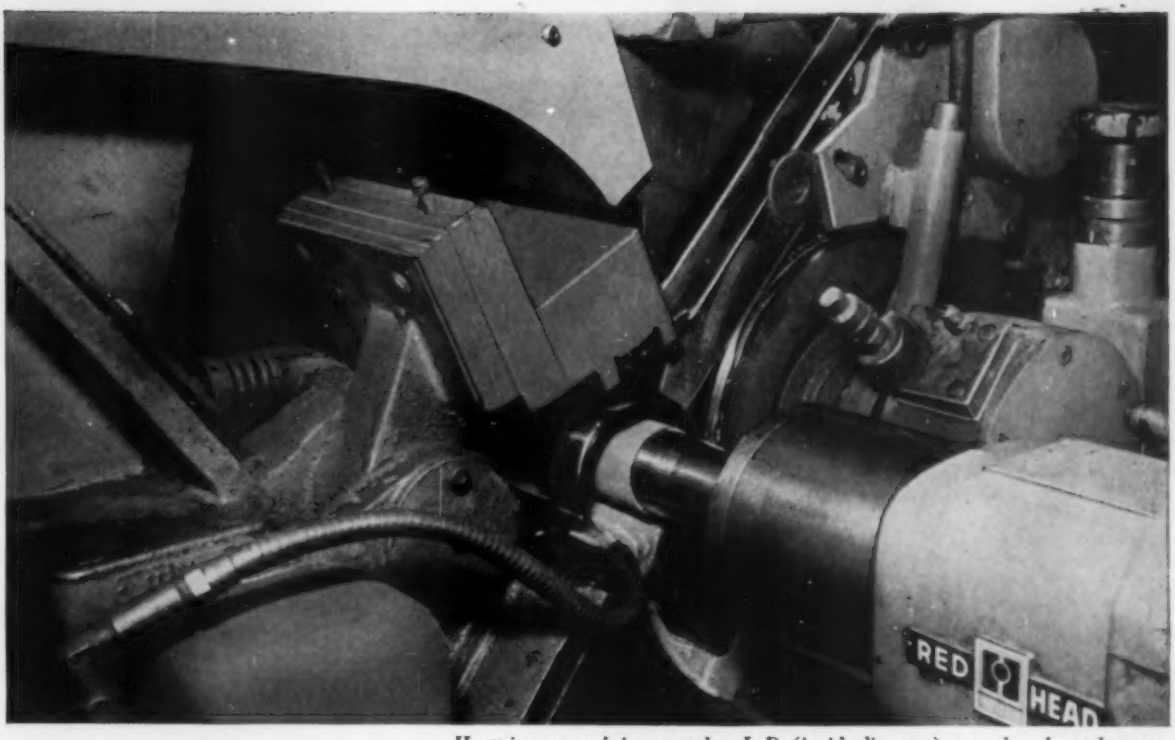
2. HEAVIER FITS SIMPLIFY MOUNTING, REDUCE COSTS

Hyatt originated the carburized race and the system of relatively heavy inner race fits to simplify bearing mounting and eliminate the need for retaining devices. Practically all HYATT inner races are made from nickel alloys of the carburizing type. They permit mountings of the simplest type and lowest over-all cost. Furthermore, the shoulders of HYATT carburized races will withstand considerably greater impact loads than will ordinary races. (Figures 3 and 4.)


HYATT METRIC SERIES OUTER RACES MAY BE MADE OF EITHER HIGH CARBON OR CARBURIZING GRADE ALLOY
HYATT METRIC SERIES INNER RACES ARE ALWAYS MADE OF CARBURIZING GRADE ALLOY
1




A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT
3

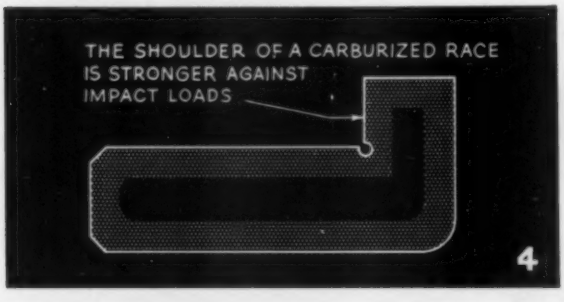


Hyatt inner race being centerless I. D. (inside diameter) ground to close tolerances.

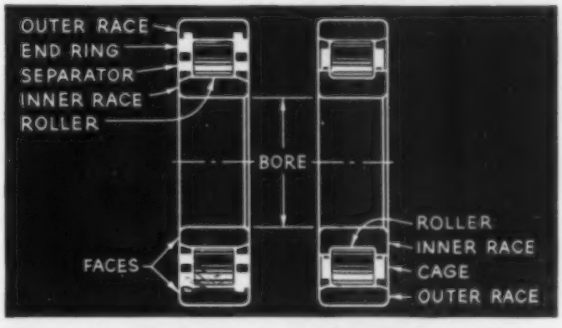
There are two fitting specifications which apply to HYATT inner races, depending on whether the inner race rotates or is stationary in operation. Remember, with both inner and outer race, the rotating member is assembled with heavier fit.

3. HYATT INNER RACES CAN BE EASILY SHRUNK ON SHAFTS

HYATT inner races may be mounted on shafts by pressing or shrinking. Where shrinking practice is employed, first heat the race in oil held at a temperature not over 300°F, or in an electric oven under a similarly controlled temperature, until it expands sufficiently to be slipped into position. The required interference fit will develop as the race cools in place. For special conditions of fit involving hollow shafts of varying sections or multiple housings of dissimilar metals, consult your HYATT Sales Engineer from our nearest sales office.



COMPONENT PARTS OF A HYATT ROLLER BEARING



YOU WILL FIND MORE DETAILS

in HYATT Catalog No. 150. If you do not have a copy, write Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. Sales offices at Harrison, Pittsburgh, Chicago, Detroit and Oakland, California.

HYATT *HY-ROLL BEARINGS*

GM GENERAL MOTORS

FOR MODERN INDUSTRY

A Boeing B-47 Stratojet medium bomber gets a take-off assist from 30 Phillips Petroleum Company M15 JATOs.

N-A-X HIGH-TENSILE is readily formed and welded. Here, before welding, a worker sizes the container's aft head, drawn by a 250-ton press. Bottom forging is locked in.

N-A-X HIGH-TENSILE STEEL FORMS AND WELDS READILY

Formability: Even at the higher strength levels (50% greater than mild carbon steel) this material can be cold formed and drawn into very difficult stampings and cold formed shapes.

Weldability: Its weldability by any process is excellent, maintaining toughness through a wide range of temperatures. Under-bead cracking tests are excellent. Using American Welding Society standard bead-weld testing, shows under-bead hardness rises only to 95 Rockwell from 80-85 Rockwell prior to welding.

Make *your* product better, too—
with this high-strength steel

How N-A-X® HIGH-TENSILE STEEL

supplied the money-saving answer to a critical take-off problem

JATO rockets boost heavily laden planes into the air faster, let them operate from shorter runways. A new JATO developed by Phillips Petroleum Company required a case that would endure a pressure of 1,000 pounds per square inch at the high blast temperatures. Yet it must be lightweight, easily fabricated, economical.

In 1954, 100 JATO cases of N-A-X HIGH-TENSILE steel were tested at Air Force Plant 66 near McGregor, Texas, where Phillips Petroleum is contractor-operator.

Result: The N-A-X HIGH-TENSILE case passed every test with flying colors. It *surpassed* the required standards for strength by as much as 20 percent.

The high-strength characteristics that make N-A-X HIGH-TENSILE a better steel for JATO fuel containers also make it better for many other types of pressure containers, where high strength and lighter weight are equally important. It is particularly suitable for Propane cylinders and pressure vessels for the chemical, automotive and oil industries, that must withstand severe interior pressures and handling abuses . . . and for such products as truck and trailer frames, wheels and bumpers, railroad and earth-moving equipment, shipping containers, pipe, and many others.

Other Important Advantages: N-A-X HIGH-TENSILE STEEL, compared with carbon steel, is 50% stronger • has high fatigue life with great toughness • is more stable against aging • is more resistant to atmospheric corrosion. It polishes to a high luster at minimum cost • has greater resistance to abrasion or wear • offers greater paint adhesion.

With N-A-X HIGH-TENSILE you can design longer life, strength with lightness, and economy into your products. Let us show you how.

COMPANION HIGH-STRENGTH STEEL IN THE N-A-X FAMILY

N-A-X FINEGRAIN. A low-alloy high-strength steel ideally suited for applications where the enhanced resistance to atmospheric corrosion of N-A-X HIGH-TENSILE is not required.

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HIGH-TENSILE STEEL

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GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan
Division of
NATIONAL STEEL CORPORATION

N-A-X Alloy Div., Dept. C-1
Great Lakes Steel Corp., Detroit 29, Mich.

☐ Please send me 8-page illustrated technical catalog on N-A-X HIGH-TENSILE Steel.

☐ Please have your representative contact me.

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3X cut-away view of KLIXON KX4 Sine Switch

ACTUAL SIZE

Get precision switching completely free from environmental conditions ...with the KLIXON KX4 Sine Switch

Here's a small precision switch especially designed for use in aircraft and guided missiles, jet engine speed and fuel controls, signalling devices and precision instrumentation, chemical and packaging machinery, and industrial equipment.

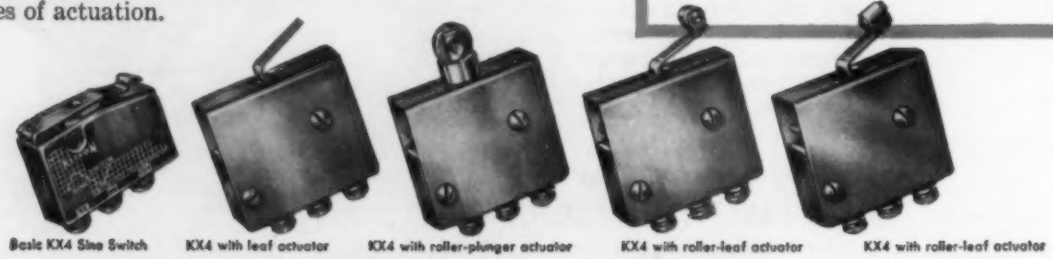
KLIXON KX4 Sine Switches are sealed in an extra strong steel case designed to withstand heavy impact and compression loads. True hermetic sealing is achieved with a metal "wave type" diaphragm at the actuating lever.

The KLIXON KX4 Sine Switch has maximum clearances between current carrying parts. It can be ganged easily for multiple pole operation and is adaptable to many types of actuation.

Other features of the KX4 include:

- **HIGH CURRENT CAPACITY** . . . unique design of Sine Blade eliminates knife edges . . . provides double current path through blade . . . gives efficient heat dissipation and long electrical life.
- **HIGH SHOCK AND VIBRATION RESISTANCE** . . . precise operations unaffected by shock as high as 200 g's . . . vibration of 40 g's, 0-500 cps.
- **WIDE AMBIENT TEMPERATURE RANGE** . . . continuous operation at temperatures as high as 200°F . . . precise operation unaffected under rapid cycling from −65°F to +200°F within five minutes.
- **STANDARD SIZE** . . . meets mounting requirements of Military Standard AN3234.

Technical Data Sheets on the KX4 and other KLIXON Sine Switches now in production are available. Write for Bulletins PRSW-2, 3, 4 and 5.



Basic KX4 Sine Switch | KX4 with leaf actuator | KX4 with roller-plunger actuator | KX4 with roller-leaf actuator | KX4 with roller-leaf actuator

METALS & CONTROLS CORPORATION
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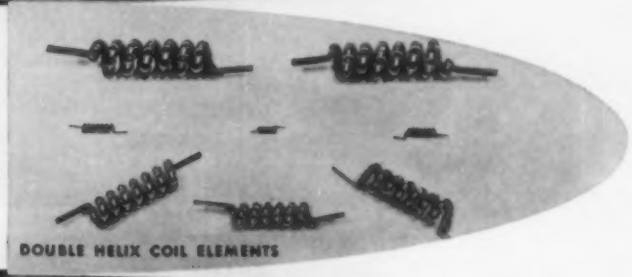
Truflex® Thermostat Metal Parts by

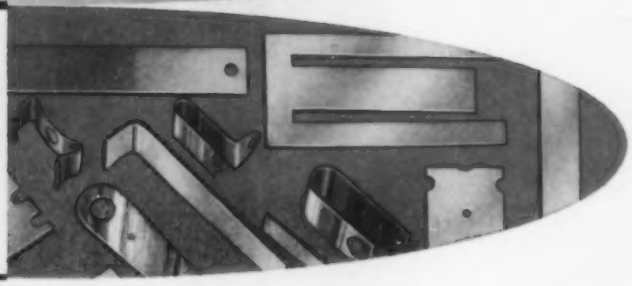
GENERAL PLATE

Give you Consistent

Performance



with Economy



For better control, indication, or compensation of temperature in your products, look to Truflex Thermostat Metal parts. Here's why:

- Every piece, whether in lots of 10 or 10,000, is a duplicate of the original — eliminating rejects and costly adjustments in assembly.
- Truflex Thermostat Metal Parts and Sub-Assemblies are engineered to your specifications, ready for installation.
- Production problems, special equipment, prolonged experimental work, expensive calibrating operations are all eliminated when you use Truflex parts.
- If you prefer to make your own parts, Truflex Thermostat Metals are available in extra long coils or flat strips manufactured to exacting specifications.

You can profit by using General Plate clad metals.

Why not send us a drawing of one of your thermostat metal parts, and let us show you what we can do? No obligation.

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1004 Forest Street, Attleboro, Mass.

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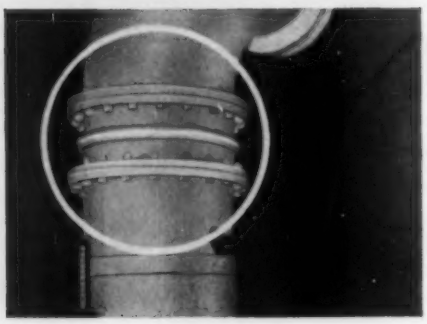
How long can a U. S. Rubber Expansion Joint last



...some have been on the job since 1926, the year they were invented!

Here are just a few reasons why *these flexible connections are used in pressure or vacuum pipe lines...*

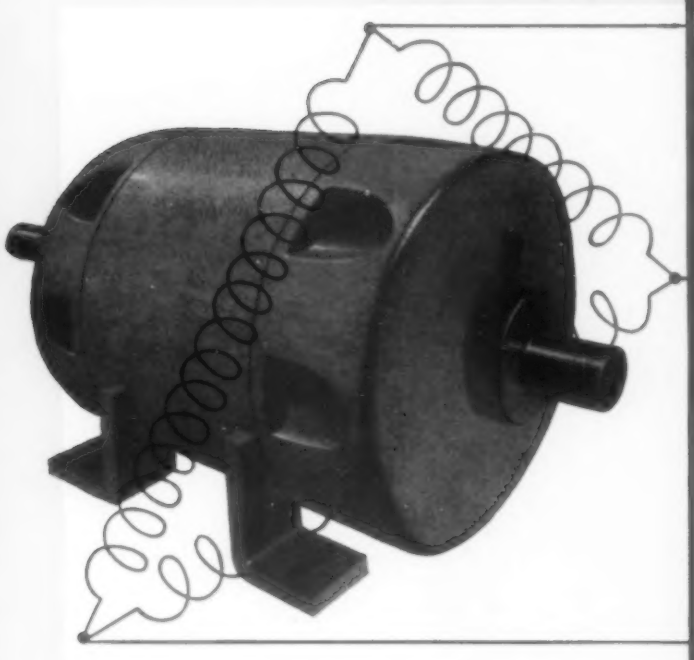
- U. S. Rubber Expansion Joints are resilient and, therefore, do not, like metal, set permanently when compressed.
- Constant flexing merely keeps "U. S." joints "alive"...prevents them from becoming brittle.
- They absorb both axial *and* lateral deflection far more than metal joints. Greater insulation against vibration and pump noises is provided.
- There is never any electrolysis, corrosion or erosion.
- U. S. Rubber joints handle pressures from 40 lbs. to 125 lbs. Compare!
- The outside diameter of the arch is smaller than that on metal joints. Face-to-face dimensions (even with multiple arches) are smaller.
- Weight is much less. This, plus the fact that no gasket is needed between flanges (unlike metal joints) results in a more easy installation, lowering the cost.

"U. S." was the first to develop rubber expansion joints. They are at work in every kind of industry, prolonging the life of equipment in pressure or vacuum pipe systems. Obtainable at any of the 28 "U. S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y.

US RUBBER

Mechanical Goods Division

United States Rubber



SIMPLE DEPENDABLE protection against phase failure and phase reversal

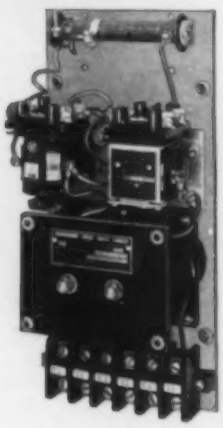
A-B protector opens control circuit in 3 to 4 cycles...under all load conditions

When men, motors, or the driven machines can be "hurt" by "phase failure" or "phase reversal" . . . the new Allen-Bradley Bulletin 812 should be used as a low cost and reliable "safety" insurance. It detects phase failures and reversals electrically, and within not more than 3 or 4 cycles, opens the motor control circuit—regardless of motor load (including no load)—and thus stops the motor.

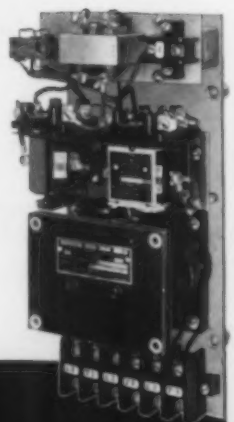
The Bulletin 812 Type A relay protects motors against all phase failures. The Type B relay protects motors against loss of a phase and reversed phase rotation. For the first time, dependable protection is provided for motors supplied by Wye-Delta and Delta-Wye power systems having the neutral ungrounded or not connected to the circuit.

Bulletin 812 relays offer positive protection against motor or machine damage due to opening a primary line—and under all "load" conditions. No field adjustment is required. Remote reset is inherent. Furthermore, as a static device which does not rely for its operation on "motor" revolution the possibility of failure to operate is eliminated.

Bulletin 812 relays are built in four sizes which will reliably protect motors with full load currents from 1.25 amperes to 300 amperes. Let us send you more information about this dependable answer to phase failure and phase reversal problems.



Bulletin 812 Type A phase failure relay protects a 3-phase motor against loss of a phase.



Bulletin 812 Type B phase failure and phase reversal relay protects a 3-phase motor against both loss of a phase and phase reversal.

ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

A-B Quality

Allen-Bradley Co.
1316 S. Second St.
Milwaukee 4, Wis.

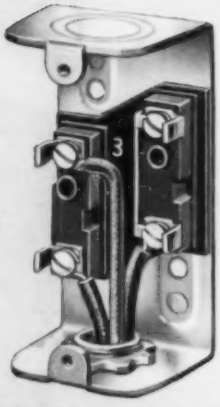
In Canada—
Allen-Bradley Canada Ltd.
Galt, Ontario

4-57-MR

new Allen-Bradley Bulletin 800 Standard-duty Push Buttons

CAN BE WIRED IN HALF THE TIME!

CONTACT MECHANISM IN THE COVER—COMPLETELY PROTECTED FROM CARELESS SCREWDRIVERS AND CARELESS WIRING.



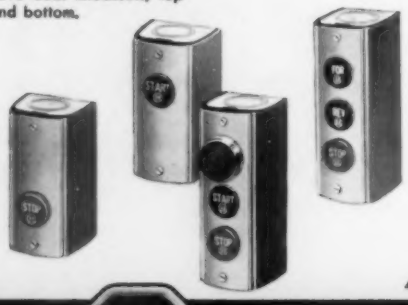
WIRING TERMINALS IN THE BASE —COMPLETELY EXPOSED FOR EASY WIRING.

Here's an entirely new idea in push button stations—a wrap-around cover which contains and protects the contact mechanism. Removing the cover exposes all terminals for instant and easy wiring. Heavy, silver plated contacts connect the push button assembly in the cover with the terminals in the base.

Matching ribs in the cover and notches in the molded terminal base eliminate the possibility of having wiring connections made incorrectly. A molded, bakelite shield protects the contact mechanism and prevents careless wiring from interfering with contact operation. All push button contacts are silver and of the double break construction.

Specify the new Allen-Bradley standard-duty station on your next order. Its installation time-saving feature, alone, should make you a regular customer!

Bulletin 800 standard-duty push buttons—with strong, gray, molded cover are "good looking" and "safe" in operation. All stations have dual knockouts, top and bottom.



4-57-MR

SELECTOR SWITCH

You can't beat this for convenience—a selector switch with the same easy-to-wire construction as the push buttons, shown above—plus the feature that you can change—*in seconds*—from two position to three position (or vice versa)! The correct name plate is furnished with each switch. See for yourself how easily this is accomplished.

CHANGE IT FROM 2 POSITION TO 3 POSITION (or vice versa)...in 30 Seconds!

A-B Quality

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QUALITY

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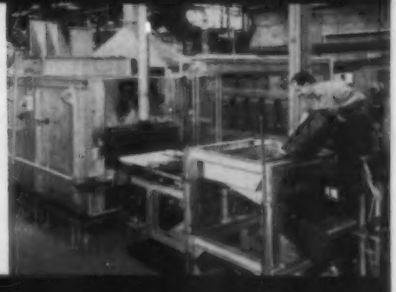
carbon-stabilized

PARKER-KALON stress relieved socket screws

All P-K® Socket Screws are hardened in a propane atmosphere in this Westinghouse furnace to prevent carbon loss, eliminate adsorption of foreign gases. Part of P-K's controlled processing which assures consistent high quality, prevents precipitation or crystallization. Another good reason why . . . *If it's P-K . . . It's O-K!*



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PARKER-KALON® fasteners

HASTELLOY Alloys in Convenient Forms

Trade-Mark

...for Superior Corrosion Resistance

EXTRA CORROSION RESISTANCE

Equipment made of HASTELLOY alloys is giving good service handling such severe corrosives as boiling hydrochloric and sulphuric acids. The alloys are also used to handle these acids at lower temperatures and in all concentrations. HASTELLOY alloys are the most economical material for handling such reactive materials as hydrogen fluoride and wet hydrogen chloride gas at high temperatures. The alloys are also highly resistant to wet chlorine, acid salts, phosphoric acid, nitric acid, and organic acids.

AVAILABLE IN STANDARD FORMS

HASTELLOY alloys are available in all of the standard mill forms—sheet, plate, bars, rods, wire, tubing, pipe, fittings, and fasteners. They can be obtained as sand and investment castings.

TEST THEM NOW

Samples for trying HASTELLOY alloys under actual plant conditions are available without charge. Get in touch with the nearest Haynes Stellite Company office and describe the corrosive conditions involved.

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

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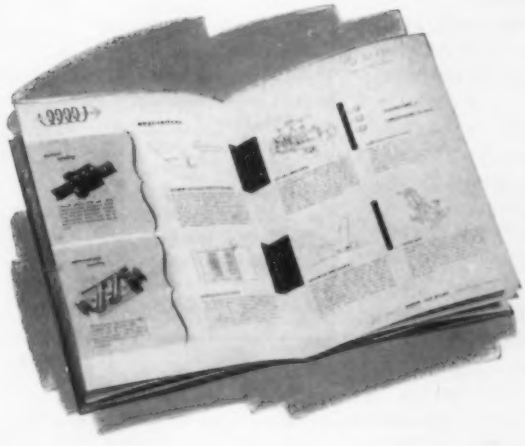
FREE! YOUR NEW ACTUATOR and SPLINE "PROBLEM SOLVER"!

New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.



SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

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Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 1J, Saginaw, Michigan

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Saginaw ball bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

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- *New material for vacuum-forming*
- *Electric shaver's comb framed in plastic*
- *Coating improves appearance, saves in production*

When you're working on a new design idea, find out if there's a plastic ready and waiting to help do a better job. A BAKELITE plastic can often extend the range of your ideas—help get a jump on competition—because there's something new in plastics just about every day.

In plastics, Bakelite Company is your leading source of information, as well as of materials. For 46 years it has been a leader in the field, offering the widest variety and number of plastics and resins. You can choose from BAKELITE Brand Phenolics, Vinyls, Styrenes, Polyesters, Polyethylenes, Epoxies, Silicones, and Impact Styrenes. In addition, Bakelite Company offers the aid of its extensive laboratory facilities and technical resources in applying modern plastics to your problems.

1 New Polyethylene Developed for Vacuum-Forming

New BAKELITE Brand Polyethylene DFD-4030 permits the application of polyethylene to the economical process of vacuum or thermo-forming—a development of major importance.

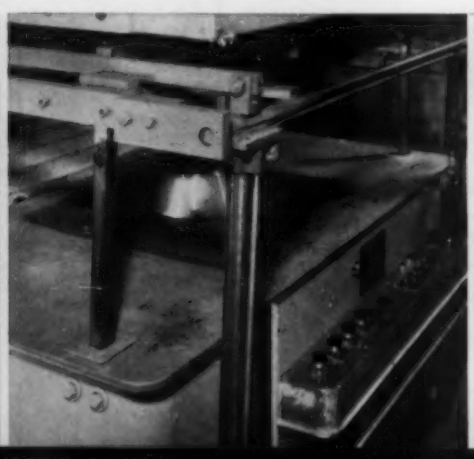
The first of its kind, DFD-4030 has been specifically compounded for sheet extrusion and vacuum-forming. This material provides ease of fabrication, bright color possibilities, light weight, and chemical resistance, together with the economy of vacuum-forming. Products made from it possess an attractive appearance, characterized by high gloss, complete freedom from skinning, and improved stress cracking resistance due to a high molecular weight. Colorants are completely dispersed, with no streaking.

Designers can apply the advantages of production economy, deep draws, and eye-appeal to a wide variety of products, including housewares and packaging items. Some typical properties of the new compound are shown in the adjoining table. You can get more information by writing to **Dpt. WP-145** for KABELITEMS No. 7.

Specific Gravity (D792-50 Method A)	0.92
Melt Index (D1238-52T)	1.7-2.4
Tensile Strength (D412-51T) psi	1800
Per Cent Elongation (D412-51T)	550
Brittle Temperature (D746-55T), 80% non-failure, deg. C.	−80
Stiffness Modulus (Torsion) at 23 deg. C. (D1043-51)	22,000
Durometer Hardness (D676-49T)	40 at 75 deg. F. 28 at 140 deg. F.
Coloring Properties	Unlimited

High gloss is evident on this polyethylene sheet being placed in clamping frame just prior to vacuum-forming.

Heater drawn forward over polyethylene sheet with bowl mold in position. Low mold cost is an important advantage of the vacuum-forming process.

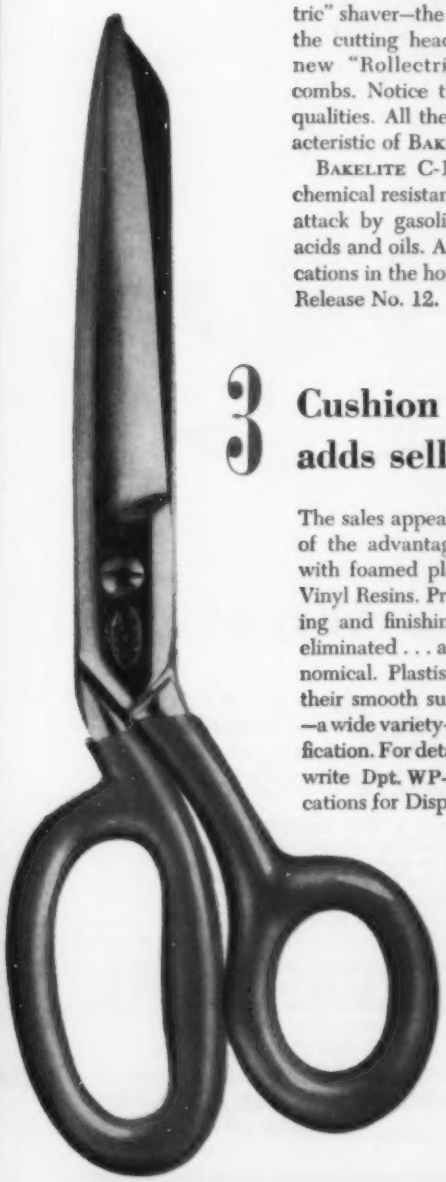


Heated polyethylene sheet drapes over mold before vacuum is applied. DFD-4030 is readily deep-drawn to large-size sections.

2 C-11 Plastic crowns the newest "Remington"

Take a look at the upper section of the new Remington "Rollectric" shaver—the part that houses the cutting head and holds the new "Rollectric" steel roller combs. Notice the even color and fine finish. Strength without bulk is another of its qualities. All these features—strength, finish, color, and good molding details—are characteristic of BAKELITE C-11 Plastic.

BAKELITE C-11, an acrylonitrile-styrene copolymer, is also notable for its superior chemical resistance. In this application, it is unaffected by perspiration. It also withstands attack by gasoline, turpentine, detergents, ink, coffee, carbon tetrachloride, and food acids and oils. As a result, BAKELITE C-11 Plastic is being used for more and more applications in the housewares and packaging fields. Write **Dpt. WP-145** for Molding Technical Release No. 12.



3 Cushion coating on handles saves finishing, adds selling point

The sales appeal of color and comfort are just part of the advantages resulting from handles coated with foamed plastisols based on BAKELITE Brand Vinyl Resins. Production benefits too. Hand polishing and finishing of rough castings can often be eliminated . . . applying the coating is fast and economical. Plastisols resist moisture and acids, and their smooth surface is virtually dirt-proof. Colors —a wide variety—stay true, permit easy visual identification. For detailed information on these materials, write **Dpt. WP-145**, and ask for "Industrial Applications for Dispersions of Vinyl Resins."

Cross section shows relative thickness of resilient coating that provides a smooth, comfortable grip for scissors handles and conforms to uneven under-surface.

There's more to design with in

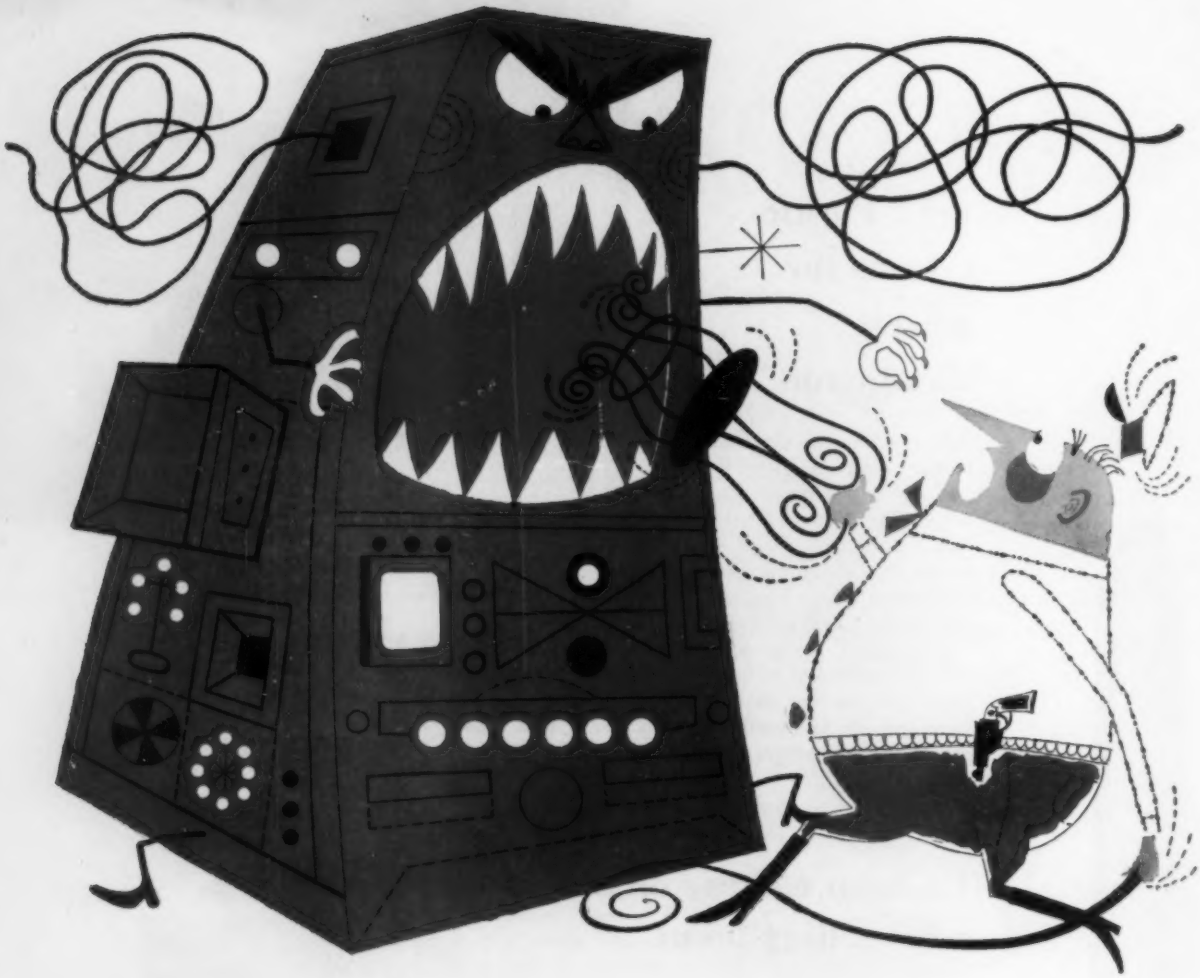
PHENOLICS
STYRENES
IMPACT STYRENES
POLYETHYLENES
VINYLS
EPOXIES
POLYESTERS
SILICONES

BAKELITE
BRAND
PLASTICS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.



Taming a wire fabricating machine?

Call American Steel & Wire!

Wire machines can be ornery. They seem to have a brain that delights in fouling up a high speed production line.

Very frequently, your American Steel & Wire representative can tame things down. With over a century of company experience behind him, he may be able to suggest a minor change in wire specifications, die construction or fabricating procedure that will solve the problem.

At AS&W, we *use* a lot of wire in our own plants, and have learned a lot of little tricks that are yours for the asking. Just call your American Steel & Wire representative.

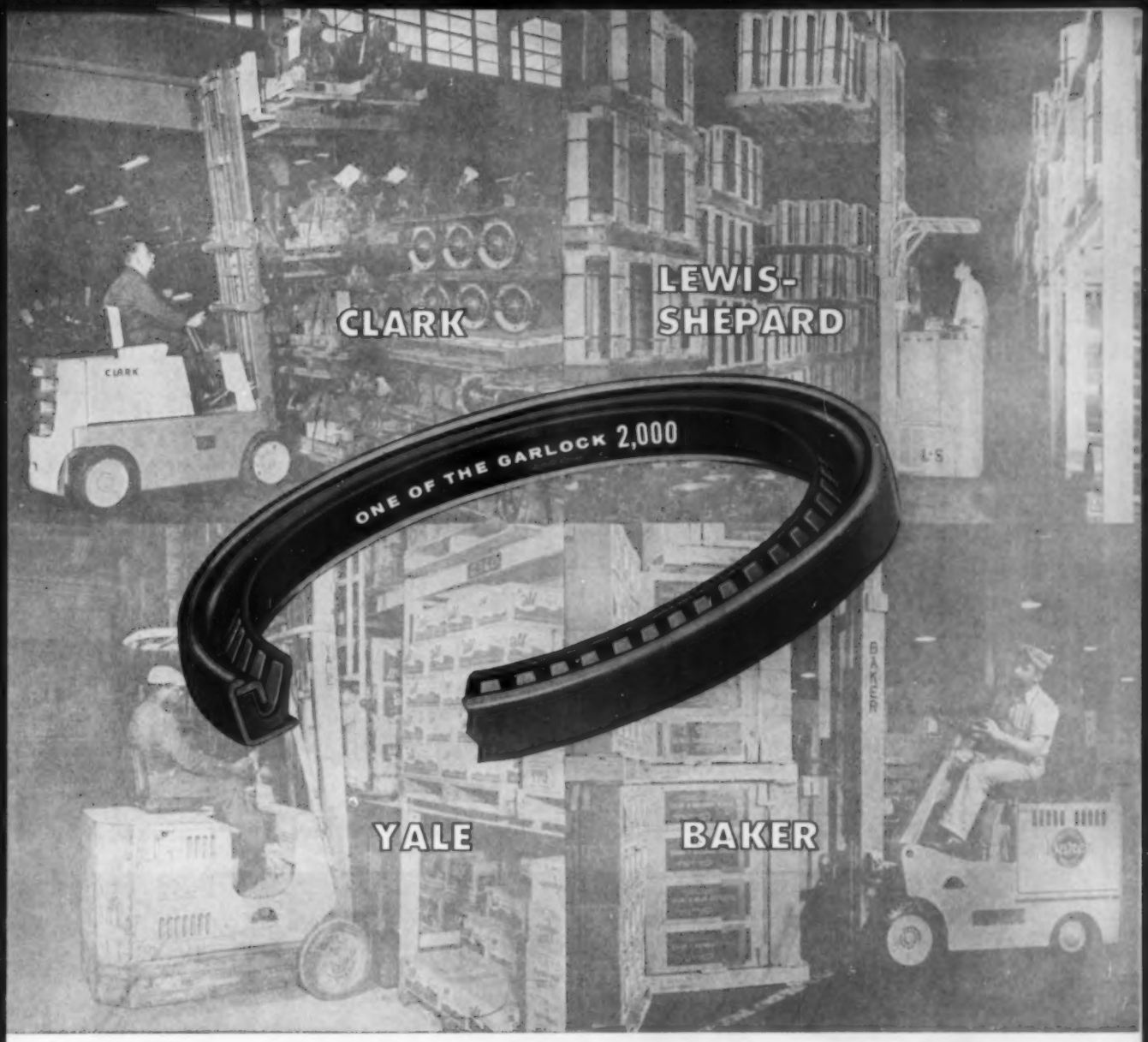
AMERICAN STEEL & WIRE DIVISION
UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, O.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN MANUFACTURERS WIRE

USS

AMERFINE—*high quality fine wire.*
AMERSPRING—*music steel spring wire.*
AMERTEMP—*heavy-duty oil-tempered wire.*
AMERLOY—*alloy heading wire.*
AMERHEAD—*uniform heading wire.*
AMERSTITCH—*extra-tough metal stitching wire.*

UNITED STATES STEEL



Why Leading Lift Truck Makers Specify Garlock KLOZURE* Oil Seals

The standard sealing element in a Garlock KLOZURE Oil Seal is a unique synthetic material molded to very accurate dimensions. It is non-abrasive, free-running; oil, grease, heat, and cold resistant; impervious to water, mild acids, and alkalies. It is also extremely durable and resilient.

That's why 20 leading Lift Truck manufacturers use KLOZURE Oil Seals for sealing-in bearing lubricants, and for protecting bearings from the abrasive action of dust and dirt.

For unusual service requirements KLOZURE Oil Seals are supplied with sealing elements made of silicone rubber for temperature extremes; or Teflon to resist strong acids, and other chemicals.

If you have a sealing problem, why not ask your Garlock representative for his recommendations from "The Garlock 2,000" . . . two thousand different styles of packing, gaskets, and seals for every need. It's the only complete line. Call Garlock today, or write for KLOZURE Oil Seal Catalog No. 20.

*Registered Trade Mark

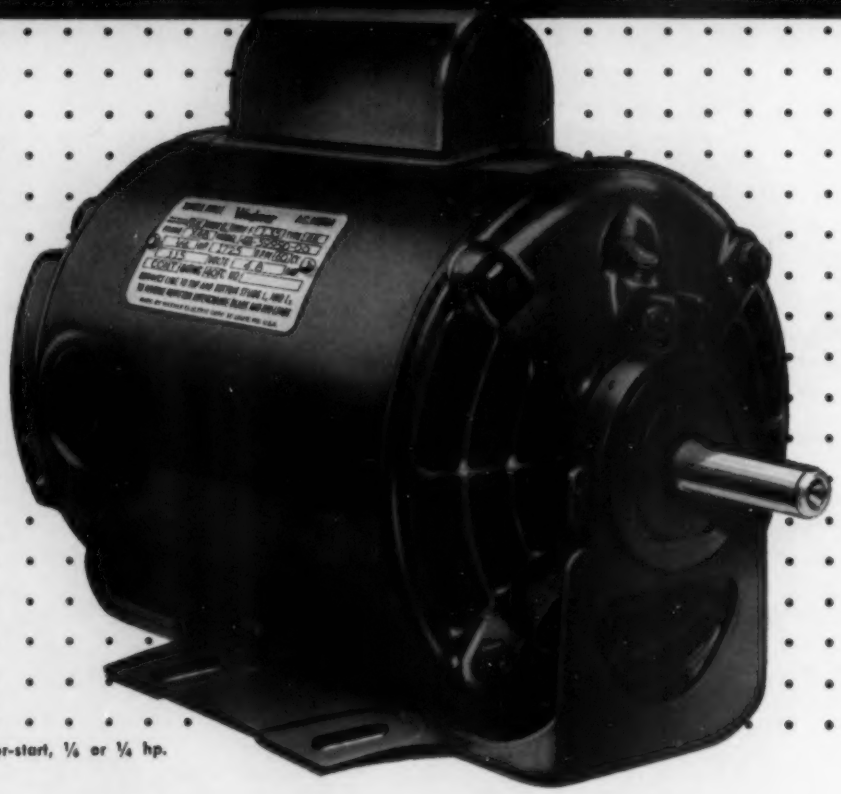
THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

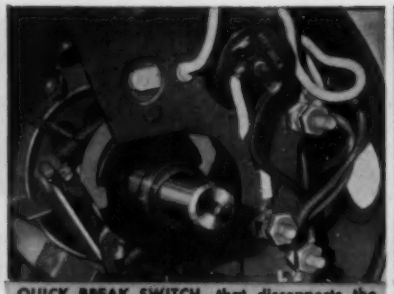
Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

IT'S SMALLER!... IT'S LIGHTER!...



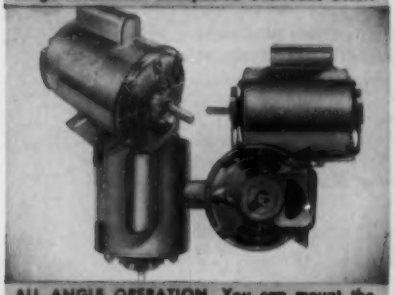
Type RK, Capacitor-start, ⅛ or ¼ hp.

• MYLAR-PAPER LAMINATED SLOT INSULATION combines top moisture resistance with high dielectric strength and thermal stability—gives the Wagner "48" more application versatility, longer life when unexpected overloads occur.



QUICK BREAK SWITCH, that disconnects the starting winding and capacitor from the line at a predetermined speed, makes and breaks with minimum arcing — is dependable and trouble-free.

BABBITT LINED BEARINGS give smooth performance. They stand heavy pressures with low temperature rise, have superior anti-seizure and non-scoring characteristics, are corrosion-resistant.



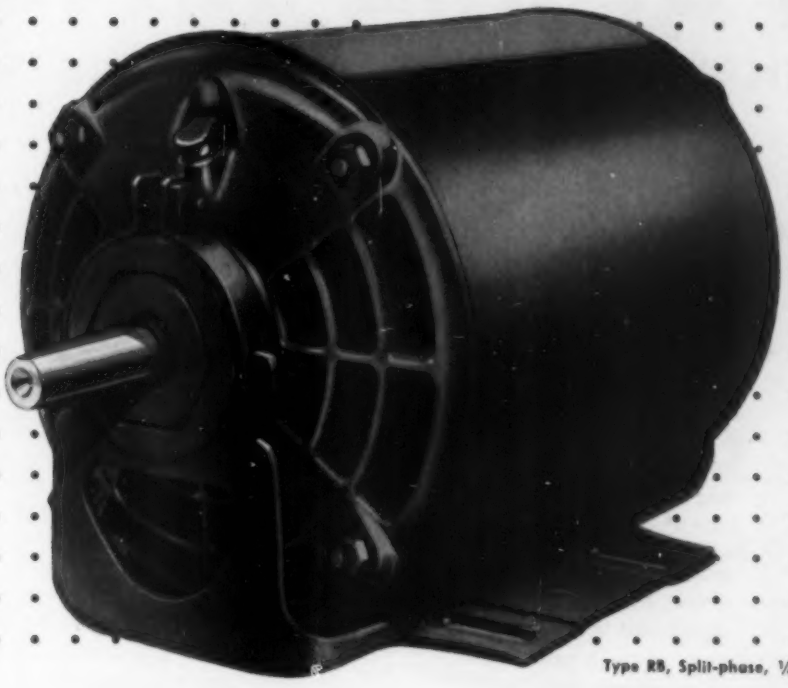
ALL ANGLE OPERATION. You can mount the Wagner "48" at any angle. A new lubrication system assures positive protective lubrication in any position.

LIGHT WEIGHT STEEL FRAME, precision-machined for accurate endplate fit, combined with CAST ALUMINUM ENDPLATES, gives the "48" strength with light weight.

EASY TO CONNECT. Just loosen one screw for access to terminal board. EASY TO SERVICE . . . no need to disconnect leads when removing endplates.

*DuPont Trademark

IT'S RIGHT FOR MODERN EQUIPMENT!



Type RB, Split-phase, 1/6, 1/4 or 1/3 hp.

New fractional horsepower motor solves problems for the design engineer

the WAGNER "48"

Here's the 48 frame motor you've been looking for! The Wagner "48" comes in capacitor-start or split-phase type — with either resilient or welded rigid base. You get the standard 48 frame size, with from *three to eight pounds less weight per motor* than previous models of the same hp ratings!

The Wagner "48" is rugged enough to permit direct mounting, compact enough to fit in tight spots, will operate efficiently when mounted at any angle. Through ventilation assures cool operation that adds to motor life.

If you would like to test the Wagner "48", one of our field engineers will be glad to furnish a sample motor. Contact the Wagner Branch near you or write to the factory.

MS7-1

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

P&B STRIKE SETTLED!

AN OPEN LETTER TO RELAY USERS

Potter & Brumfield, inc.

Dear Friends:

Ruthless violence, culminating on February 13 with the shooting of the four-months-old baby daughter of two of our employees, focused national attention on a recent strike at our Princeton, Indiana plant.

This unjustified strike was called on November 5, 1956 in the face of our "no strike" contract with Local 1459 of the International Association of Machinists. No demands or proposals for settling the strike were made by the Union. Two Company proposals were summarily rejected.

Settlement of the strike was reached on February 28, 1957.

Our plants in Laconia, New Hampshire and Franklin, Kentucky were not affected by the strike.

Production lines were shifted from Princeton to both Laconia and Franklin plants, and employment has been greatly increased at both locations. These plans were made before the work stoppage to increase production.

Production at Princeton was resumed on December 17th, and today a normal work force is manning the remaining lines. Until recently, the training of new workers restricted our productivity, but output now is at satisfactory levels.

With three plants to serve you, we pledge our continued efforts to provide you with relays of the finest quality. Our Engineering Department welcomes the opportunity to work with you on new designs and future projects.

Sincerely,

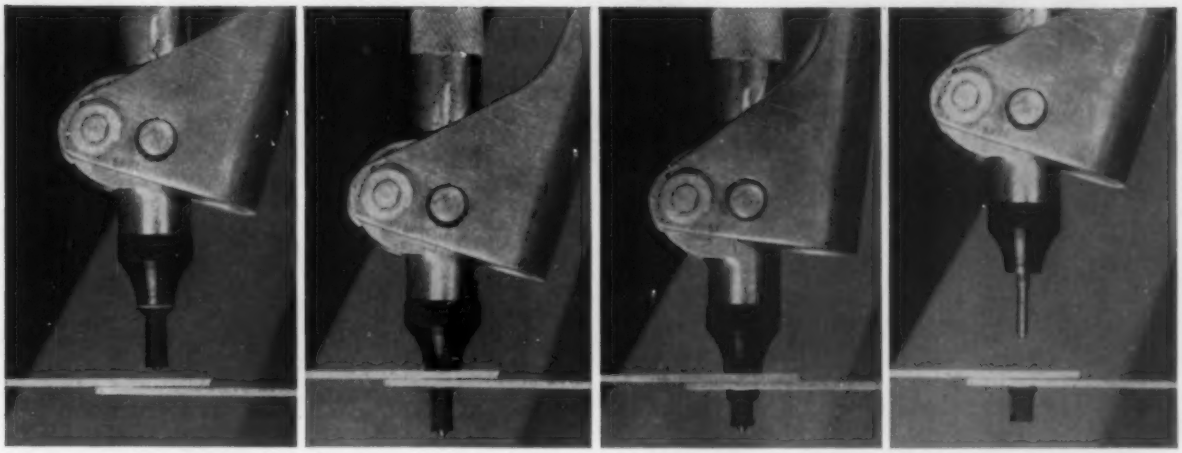
Dale V. Cropsey

Dale V. Cropsey
Vice President & Director of Sales

NOW!
3 PLANTS TO SERVE YOU

POTTER & BRUMFIELD, INC. PRINCETON, INDIANA
A Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

B.F.Goodrich Rivnut fastens thin metal and provides 6 threads... in 6 seconds!



1 Rivnut is threaded onto pull-up stud of heading tool.

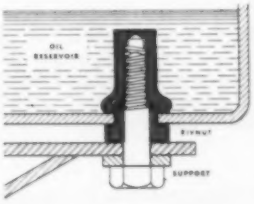
2 Rivnut is inserted—head held firmly against work.

3 Tool lever operates pull-up stud, forms bulge in Rivnut.

4 After upset, Rivnut threads are ready for screw attachment.

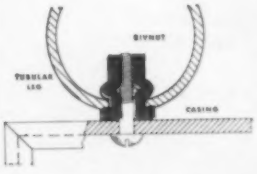
Easy way to cut assembly time and costs

SAVE TIME ON FASTENING JOBS LIKE THESE, WITH B. F. GOODRICH RIVNUTS.



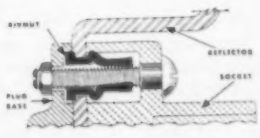
REPLACES BRAZED NUT PLATE

Rivnuts with closed ends are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated, and spacer head assures proper positioning of tank on support bracket.



ELIMINATES NUTS AND BOLTS

One worker installs a Rivnut in the tubular leg of a portable barbecue in seconds—provides a firm, accurate nut plate for screw attachment. There are no boltheads to detract from the unit's clean lines. Time is saved, too, in faster knockdown for shipping.



DOES 2 FASTENING JOBS

Rivnuts provide 6-thread nut plate for attachment from either end—or both. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket. Plug base is attached on other side. Result: fewer operations, lower assembly cost.

Rivnuts, the only one-piece blind fasteners with threads, can be installed by one person from one side of the work—in seconds. Easy installation saves up to 50% of assembly time, reduces production costs. Rivnuts can also improve the appearance of a product, make it easier to use and service.

Rivnuts are made in a variety of sizes and head styles to solve almost any fastening problem. They make tight, dependable seals that resist vibration, stay put so you can assemble and disassemble the product as often as you like without stripping the threads. Welding, tapping and thread cleaning are eliminated. And you can install them after enameling without fear of chipping.

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

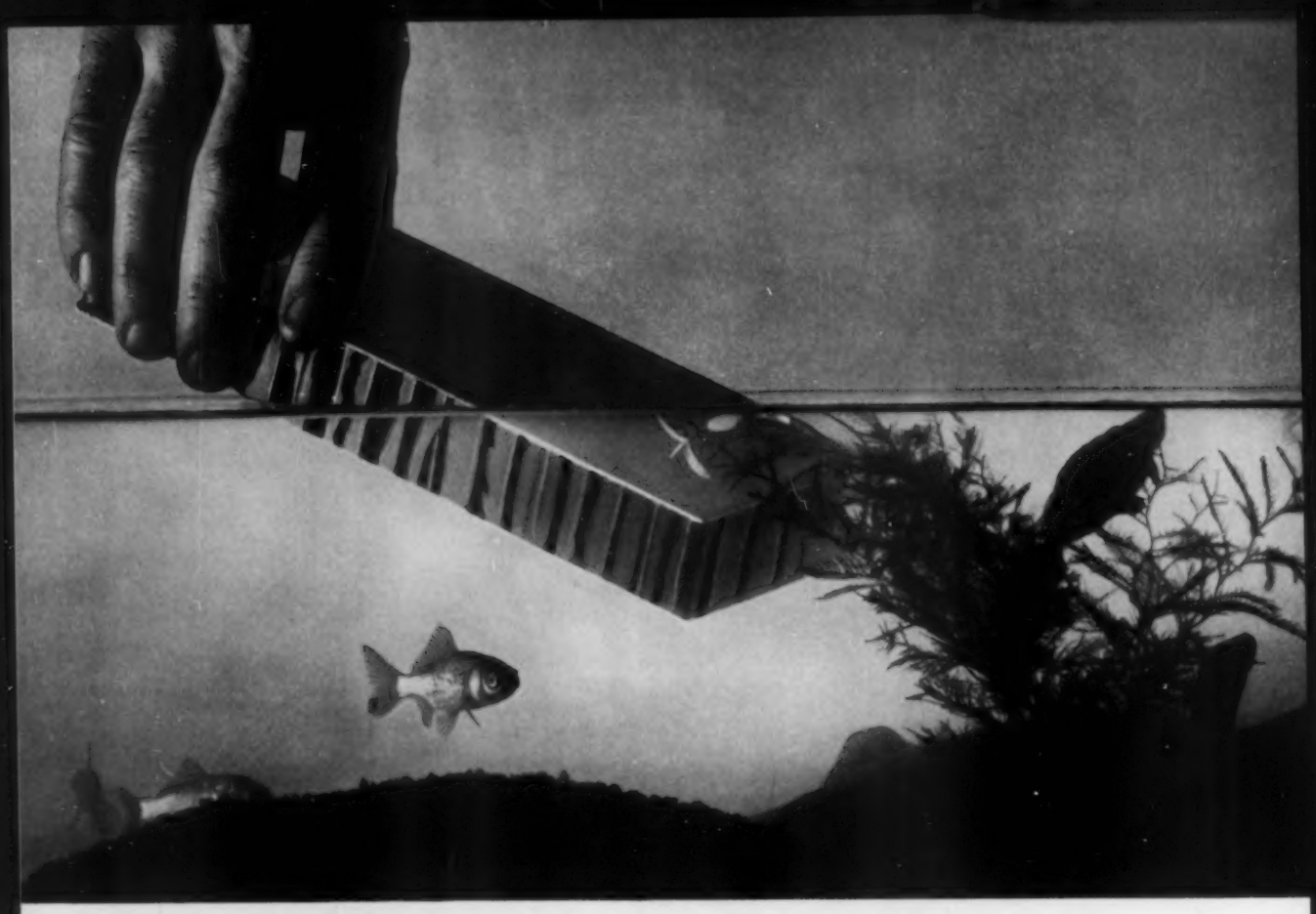
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to *B.F.Goodrich Rivnuts*, Dept. PE-47, Akron, Ohio.

B.F.Goodrich

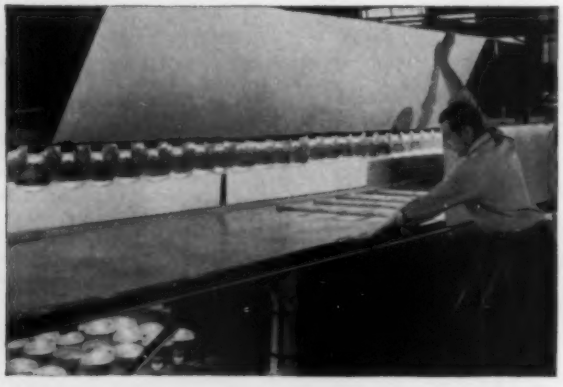
B.F.Goodrich Aviation Products

a division of The B.F.Goodrich Company, Akron, Ohio



EC-1357 for non-load-bearing uses

Even under water EC-1357 continues fastening sandwich components securely. Moisture won't hurt this tough 3M adhesive bond. Neither will normal indoor and outdoor temperatures. The curtain wall panels and other exterior units you fabricate with EC-1357 ruggedly resist weather and exposure.

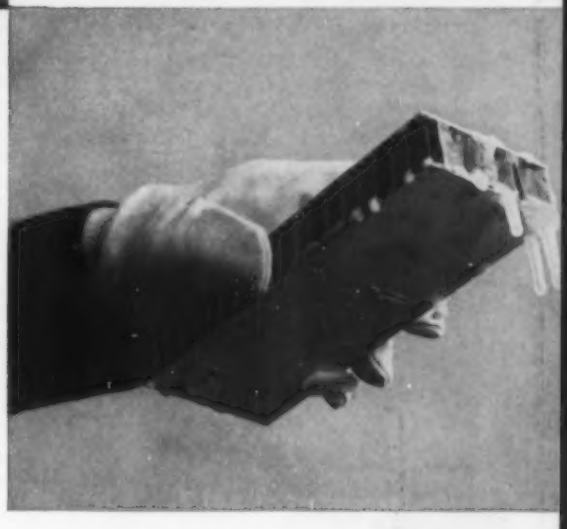


You can force-dry EC-1357 to get maximum immediate bonding strength fast. The adhesive grips skins and cores firmly together as production proceeds. You eliminate expensive drying and storage time. You gain continuous material movement from adhesive spraying to finished sandwiches. And EC-1357 builds up even more strength with age as it cures at room temperatures.

Nip roller or cold press is all you need to complete EC-1357 bonds. Whether you force-dry the adhesive or not, you can fabricate durable, high-strength sandwiches without clamps or heated presses.

EC-1177
for load-bearing uses

Rugged load-bearing ability of EC-1177 is proven by laboratory tests and experience both. In this adhesive, 3M research has combined high strength with rigidity under stress. You gain a heavy-duty bond that answers load-bearing sandwich demands.



Intense cold and heat don't faze EC-1177. It goes on bonding strongly despite severe temperatures. With EC-1177 you build high-temperature resistance right into load-bearing sandwich structures.

Beef up sandwich structures with these high-strength 3M adhesives

Put top strength into your sandwich structures right where it counts most . . . in the skin-to-core bonds.

You can with EC-1357 and EC-1177. These 3M adhesives are helping make sandwich construction the featherweight performance champ of a hundred industries.

- Flexible EC-1357 bonds lightweight skins and cores together into tough, resilient structures for non-load-bearing uses. And it goes on bonding securely despite moisture, heat, cold and exposure.

Here's durability that's vital in curtain wall panels, movable partitions and compartment separators.

What's more, EC-1357 speeds production. You can force-dry this 3M adhesive, get high bonding strength fast. Dark in color, it absorbs drying heat rapidly. With or without force-drying, you can bond sprayed surfaces cold, with just a nip roller or cold press.

- EC-1177 delivers the ruggedness your structures need to carry loads . . . high strength, rigidity under stress, great heat and cold resistance. Designers specify EC-1177 for aircraft walkways, trailer roofs and floors, platforms, shelves, tables and load-bearing partitions.

Compared to mechanical fastening, both EC-1357 and EC-1177 cut down heat transfer through panels. They reduce your risk of fracturing cores, too.

Whether you use steel, porcelainized steel, aluminum, anodized aluminum, bronze or hardboard skins . . . whether you use resin-impregnated paper, aluminum or stainless steel honeycomb cores, or cores of wood, fibrous glass or expanded cellular glass . . . investigate EC-1357 and EC-1177.

MINNESOTA MINING AND MANUFACTURING COMPANY · ADHESIVES AND COATINGS DIVISION

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PRODUCTS OF 3M COMPANY RESEARCH

SEND FOR FREE LITERATURE NOW!

Full facts on EC-1357 and EC-1177 are yours for the asking. Fill out and mail the handy coupon today. Or write on your business letterhead to the address at the right. 3M Research and 3M Field Engineers are ready to serve you.

Minnesota Mining and Manufacturing Company
Adhesives and Coatings Division, Dept. 74
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Send me free literature on 3M Sandwich Construction Adhesives EC-1357 and EC-1177. Please (do) (do not) have a 3M Field Engineer contact me at this time.

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THE *FORWARD* LOOK INCLUDES

CYPAK

. . . to provide automatic conveyor control at the new Plymouth assembly plant

Seven CYPAK* static control systems control the scheduling of auto bodies into storage conveyors at Chrysler Corporation's new assembly plant at Newark, Delaware.

In one CYPAK system, for example, the operator can select any of 15 storage lines by just pressing a button. A similar CYPAK system unloads the bodies, in pre-selected order, again through the use of just a pushbutton.

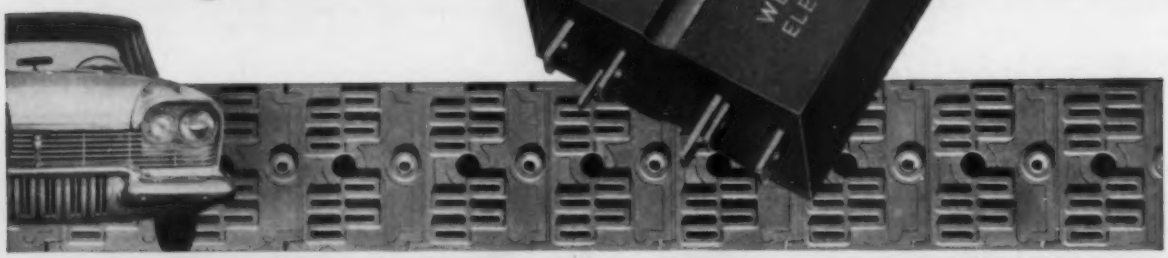
CYPAK was chosen because of its elimination of maintenance, economical operation, and reduced space requirements.

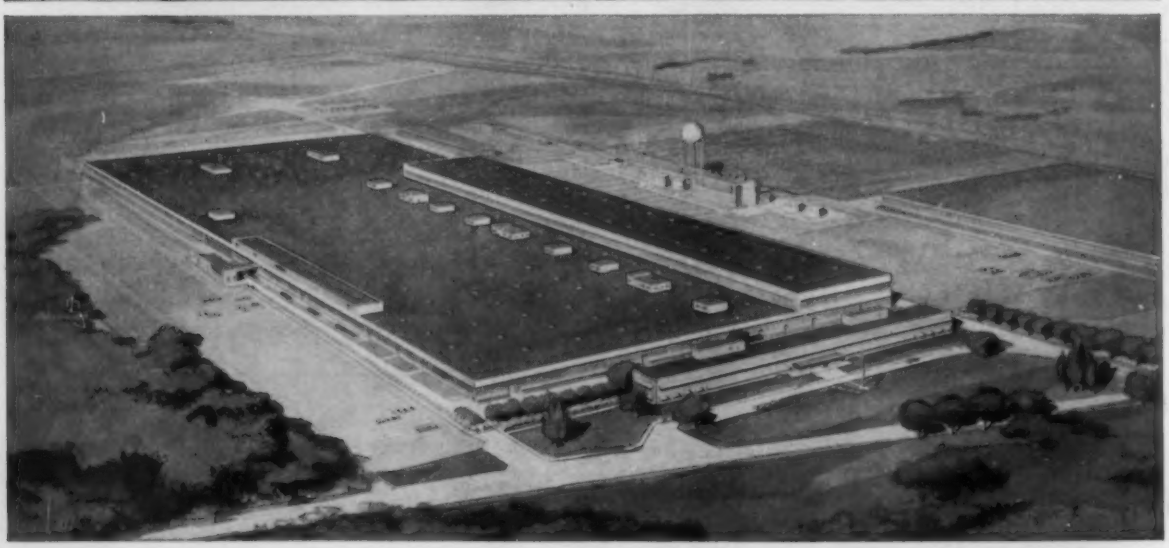
For complete information on CYPAK call your Westinghouse representative, or write Westinghouse Electric Corp., Dept. B, P. O. Box 868, Pittsburgh 30, Pa. *Trade Mark

J-22002

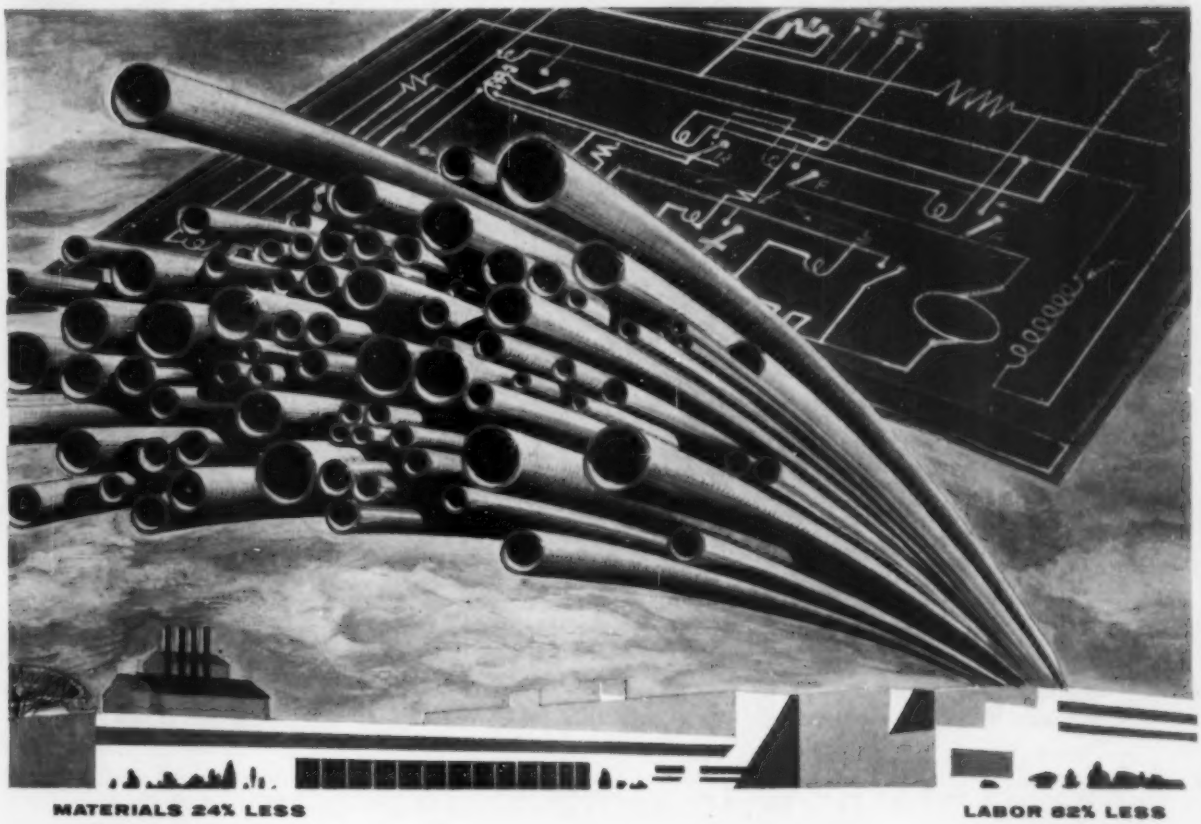
YOU CAN BE SURE...IF IT'S

Westinghouse





Naugatuck KRALASTIC



MATERIALS 24% LESS

LABOR 62% LESS

KRALASTIC electric conduit cuts costs 51%

15,060 feet of AMCO PLASTIC CONDUIT* were laid in ditches and covered with 53 yards of concrete in 116 man-hours.

Extruded of lightweight KRALASTIC®, Amco Pipe made it possible for one man to carry on his shoulder, and distribute, as much as 1,000 feet of 1½" conduit... eliminating the need for handling equipment. After laying all 24 lines in a ditch, one man could solvent weld every connection in 20 minutes... eliminating making and connecting threaded assemblies.

Naugatuck's KRALASTIC is an unusual rubber-resin blend. And because its properties are far superior to wood, metal and other plastics, KRALASTIC offers practically unlimited possibilities. For more about this tough, durable plastic material, and the advantages it offers you, write to us on your company letterhead TODAY.

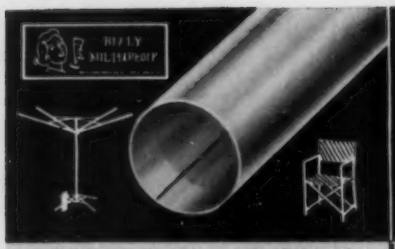
*Extruded of KRALASTIC by AMCO PLASTIC PIPE COMPANY, San Leandro, California

United States Rubber

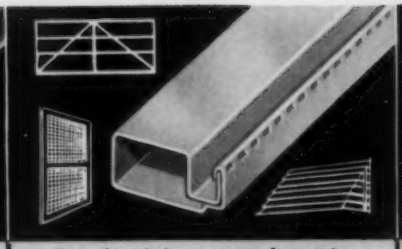
Naugatuck Chemical Division

Naugatuck, Connecticut

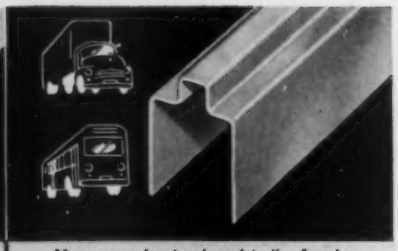
BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Phila.
IN CANADA: Naugatuck Chemicals, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.



High strength and superior finish of aluminum roll formed tubing pays off in sign frames of all sizes, aluminum furniture, clothes dryers and other products.



Parts for window screens, farm gates, car ports, awnings and other building products are economically produced with aluminum roll formed shapes.



Many complex truck and trailer framing members, bus strips and other parts are easily fabricated with aluminum roll formed shapes.

Specify ALUMINUM Roll Formed Shapes from REYNOLDS

available now in embossed patterns, paint finishes and plain or color anodized finishes

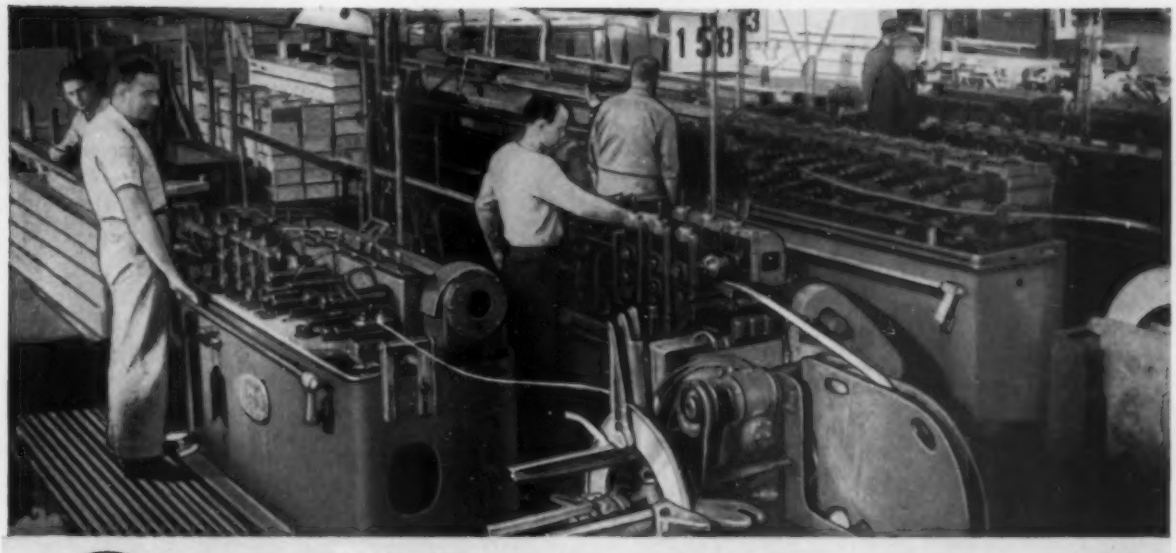
Rolling from coil stock *permits savings* that are impossible when working from flat sheet. Therefore, if you are fabricating a complex shape from flat sheet, or if you require a shape in long lengths, it will pay to switch to aluminum roll formed shapes from Reynolds.

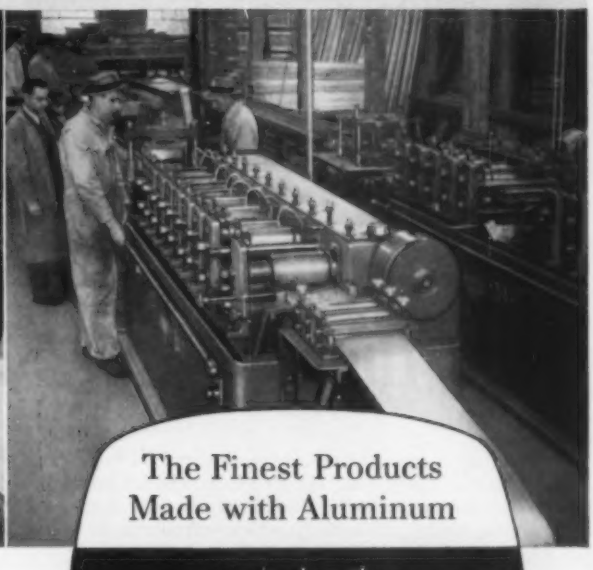
Reynolds roll forming can produce a wide range of easily fabricated shapes that *aid in design flexibility.* Closer tolerances on Reynolds roll formed shapes mean *dimensional accuracy;* better as-fabricated finishes often mean a *more attractive* product without additional finishing operations.

However, if an unusually high quality finish is important to the sales appeal of your aluminum product, Reynolds is your best source for *clear anodized, color anodized, painted* or *chemically brightened* finishes or *embossed patterns* on roll formed shapes. Reynolds new, expanded finishing facilities complement Reynolds sizable investment in roll forming machines and tooling.

For details contact your nearest Reynolds Office listed or write *Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.*

REYNOLDS ALUMINUM FABRICATING SERVICE





The Finest Products
Made with Aluminum

are made with
REYNOLDS ALUMINUM

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Write for your free copy of 8-page brochure,
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See "CIRCUS BOY", Reynolds dramatic series, Sundays, NBC-TV

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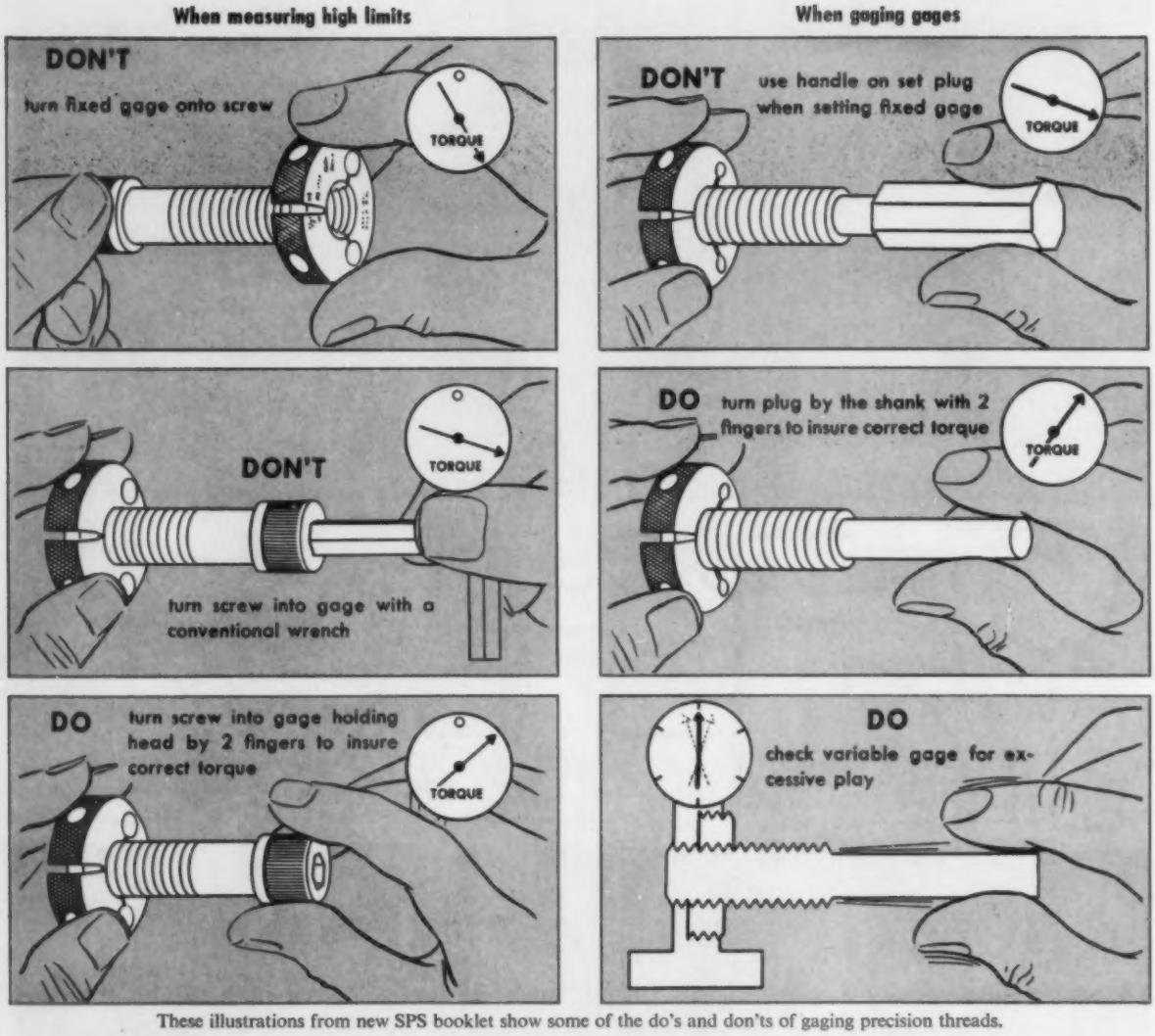


These illustrations from new SPS booklet show some of the do's and don'ts of gaging precision threads.

3A threads: what they are; how to gage them — new SPS booklet tells all

Threads made to Class 3A fit are the most precise in general use in industry. But you do not always get the 3A precision you specify. Because of many different gaging techniques that yield varying results, screws with threads well outside the Class 3A tolerance limits often pass inspection.

SPS has prepared a new booklet on this subject. It explains clearly what Class 3A threads are and the pros and cons involved in the widely varying gaging techniques in use today. It reviews the gaging of high and low limits of 3A threads, sampling techniques, and even the methods of gaging gages.

All standard UNBRAKO socket screw products fall within specified tolerance limits *no matter what method is used to gage them.* Leading industrial distributors carry complete stocks. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

Form 2239, "Class 3A Threads: what they are; how to gage them." 16 pages, with many illustrations. Write for free copy today.

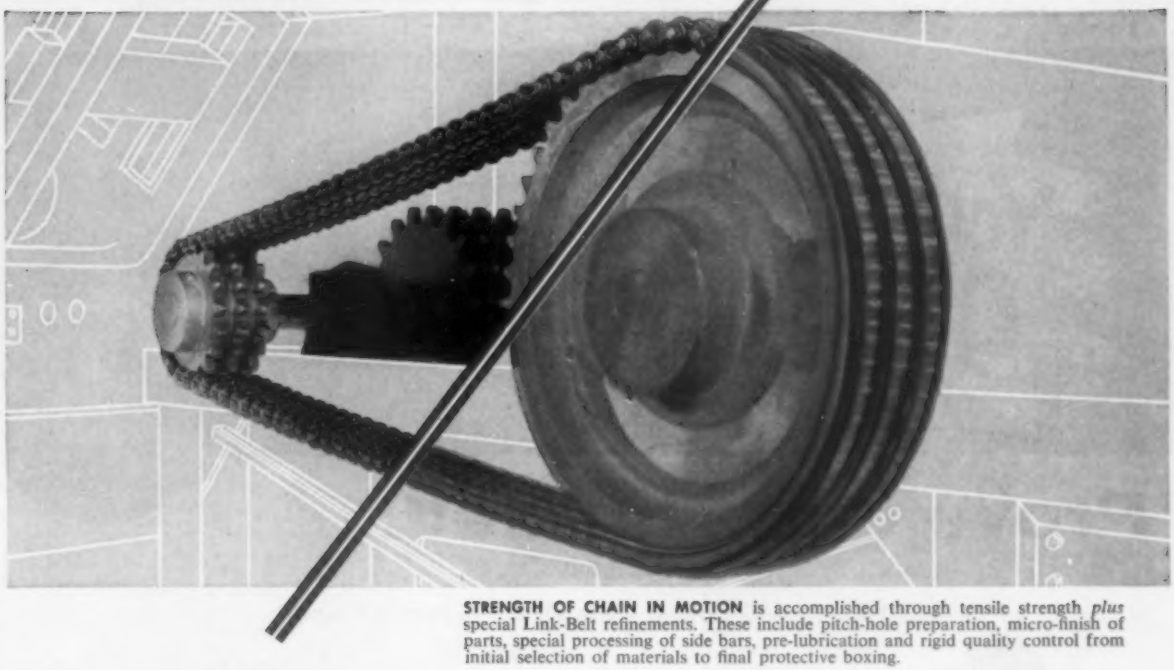
STANDARD PRESSED STEEL CO.

UNBRAKO SOCKET SCREW DIVISION SPS

JENKINTOWN PENNSYLVANIA

Not just static strength, but . . .

RESISTANCE TO TENSILE STRESS is achieved by use of properly heat-treated, accurately-machined side bars made of premium steel and fitted with properly-hardened pins, bushings and rollers. But to resist *operational* stresses, additional controls over dimensional accuracy, uniformity and roller resiliency are essential.



STRENGTH OF CHAIN IN MOTION is accomplished through tensile strength *plus* special Link-Belt refinements. These include pitch-hole preparation, micro-finish of parts, special processing of side bars, pre-lubrication and rigid quality control from initial selection of materials to final protective boxing.

dynamic strength

assures longer work-life for LINK-BELT Roller Chain

IN addition to known tensile loads, roller chain in motion is frequently subject to other operating stresses. Engagement with sprockets . . . shock of starting loads . . . centrifugal loads—there are many similar stresses.

Link-Belt's solution: greater dynamic strength, achieved through design, manufacturing and processing "extras" . . . plus a combination of other important refinements. On your equipment, it's a significant contribution to quality . . . provides more efficient performance and long life measurably beyond ordinary roller chain.

For wide design flexibility, Link-Belt roller chain covers the range of single and multiple widths—¼ through 3-in. standard pitch and 1 through 3-in. double pitch with sprockets of corresponding sizes. Ask your Link-Belt office for a copy of 148-page Data Book 2457.

LINK-BELT

ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.167

Looking for the BEST chain for a specific need? LINK-BELT makes the complete line

Silent Chain | LXS Steel Chain | Detachable Steel Link-Belt | S-815 Flat-Top Chain | Cast and Cut-Tooth Sprockets

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Yours for Just One Dollar!
Special Trial Offer of 5-yard, 36-inch wide roll of all-new 340M (medium) "Visi-Vel"
VISI-VEL
BRUNING COMPANY

Prove it to Yourself!

Use the special trial offer above to make your tests of all-new Bruning "Visi-Vel" Tracing Paper

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Compare it with any paper you are now using. Extensive tests have shown "Visi-Vel" to be at least 5% more transparent than competitive papers. And it retains its transparency—it will not leach, age, or discolor.

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Erase and re-erase to your heart's content and see how "Visi-Vel's" durable surface gives you *clean* erasures without damage. Find how beautifully "Visi-Vel" takes pencil hardnesses up to 9H without ever tearing or puncturing.

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Discover for yourself how "Visi-Vel" helps you make sharper, cleaner prints in record time. And you can count on getting the same reproduction results from the same drawings months from now. Tests show that "Visi-Vel" boosts print production as much as 25% over other leading transparentized papers.

Need It Most.. Paper Ever!

New Bruning

"VISI-VEL"

Resin-Transparentized

TRACING PAPER!

Never before has a tracing paper offered you so much to speed both drawing and reproduction, to raise the quality of your drawings and prints! Never has a drawing medium been needed so much to help meet the growing demands of a tremendous production boom!

All-new "Visi-Vel" offers the highest reproduction speed, the greatest over-all strength, and the best all-around workability of any tracing paper on the market today! Yet, it costs no more than other resin-transparentized papers.

Best for Drawing! "Visi-Vel" helps you make cleaner, neater drawings and tracings—easier and faster! Because of its exceptional strength and workability, it withstands heavy handling . . . takes erasures beautifully without damage . . . resists ghosting . . . accepts pencil hardnesses up to 9H without tearing or puncturing. A perfect balance of opacity and transparency makes it ideal for either drawing or tracing.

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You can obtain "Visi-Vel" in three different weights (thin, medium, and heavy), and in rolls or sheets. But right now, why not start with the generous trial offer of the 5-yard roll for only $1.00 or send for a free 8½" x 11" sheet. Prove to yourself the dramatic advantages of all-new "Visi-Vel!"

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☐ Enclosed find $1.00. Please send me 5-yard, 36-inch roll of all-new "Visi-Vel" tracing paper at no further cost to me.

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Linkage

The Long and Short of it . . .

HEIM *Unibal* Rod Ends

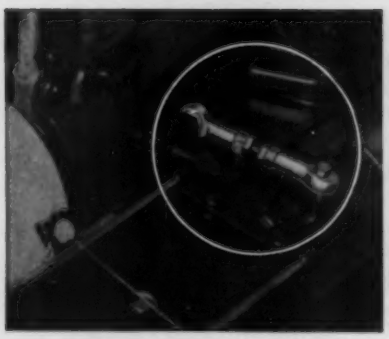
make an Infinitely Adjustable Linkage

For a short connecting rod, an externally threaded male Heim rod end can be screwed into an internally threaded female rod end to give smooth transmission of power or force.

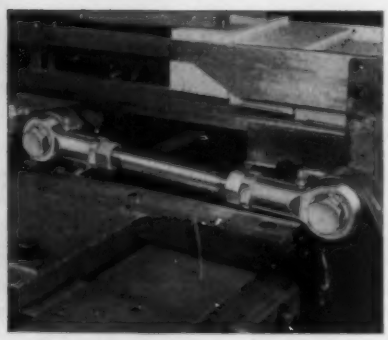
Longer connecting rod assemblies are just as simple to make by using the proper length of tube or rod between Heim rod ends.

The push-pull rods or linkages can be assembled by riveting, by swaging, by welding, or by threading and locking with set screws or lock nuts.

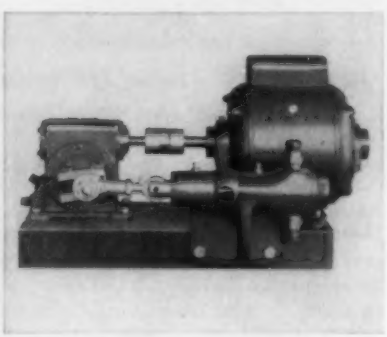
Heim Unibal Rod Ends are self-aligning, they reduce friction and lost motion, and they are economical in price and in installation time.



A short length of rod, threaded at both ends to fit two Heim Unibal female rod ends, is used on this Foster Machine Co. Model 75 pineapple coning machine. This machine is used for winding nylon, and rayon yarns to packages for use on full fashion knitting machines.



A longer length of rod, with two Heim Rod Ends locked in position with hex nuts, actuates the feed on this cartoner made by R. A. Jones & Co. Jones Constant Motion Cartoners handle millions of bottles, jars, tubes, etc. every day in a wide variety of packaging.



A male Heim rod end screwed into a female rod end forms the short linkage necessary on this Milton Roy pump. The self-aligning feature of Heim Unibal corrects the misalignment between the crank arm and the plunger moving in the pump frame.

The Heim engineering department will be glad to assist in solving your linkage problems. The Heim catalog should be at your fingertips. Please write.

THE HEIM COMPANY / Fairfield, Connecticut

THEY SMASHED INTO THAT WEIRKOTE® TILL WE COULDN'T STAND IT!

When a half-ton steel wrecking ball smashes broadside on target—mister, that's a *test*.

Yet, when Weirkote zinc-coated steel is put through that, or equally brutal punishment, its zinc coating stays skin-tight throughout the ordeal.

Think of that demonstration in terms of *your* products, production steps and cost problems.

Weirkote's continuous-process zinc coating *thrives* on toughest fabrication steps—spinning, deep drawing, roll forming, extrusion. And there's no flaking or peeling.

With Weirkote, you can eliminate the cost of plating, painting or redipping after fabrication. In many instances, you'll get prolonged die life, too, due to the lubricating quality of Weirkote's zinc coating.

Free Weirkote Booklet

Send for the new booklet on Weirkote today. Write Weirton Steel Company, Dept. D-6 Weirton, West Virginia.

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Available in
Stainless Steel
Plated Steel
Monel

Spherical
Elliptical
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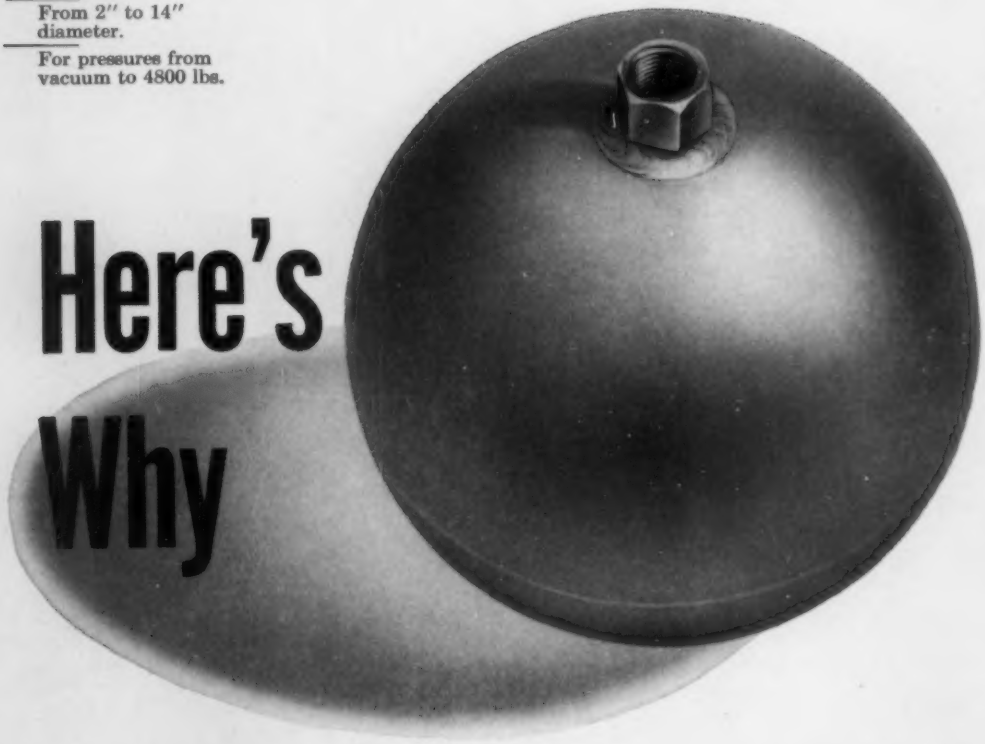
From 2″ to 14″ diameter.

For pressures from vacuum to 4800 lbs.

Here's Why



Nicholson precision welded floats are better, last longer

No mere thin-walled copper floats, these—but high tensile strength precision welded steel floats with extraordinary resistance to pressure and corrosion! Nicholson Floats give you such outstanding advantages as—

Die-formed float halves with inward rolled edges—not spun, laminated or electrodeposited;

Uniform wall thickness—float halves annealed after draws to prevent cracking;

Butt-welded seams—forming a reinforcement ring, to give floats greater resistance to external pressure.

Steel floats can be supplied—in quantity—with chromium, cadmium, or copper plating . . . or with sandblast or pickled finish. Stainless steel and Monel floats can be furnished—in quantity—rough-buffed, polished, or with welds ground smooth and highly finished for easy sterilization and cleaning.

Nicholson can deliver precision welded floats to fit your production schedule. Today, thousands of Nicholson Floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels, as well. Write for details about the complete Nicholson line.

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Helpful Data from DE LAVAL

How to calculate the efficiency of worm gearing

The efficiency of worm gearing is determined by frictional losses at the tooth contact, bearings and oil seals plus losses from oil churning and windage. A formula for efficiency at the tooth contact may be developed from a consideration of the forces at the contact. Figure 1 shows these forces acting on a developed section of the worm thread. For simplicity the pressure angle has been assumed to be zero.

The coefficient of friction of the worm and gear is a function of the materials, finish, lubrication and rubbing speed. The latter is the relative speed between a point on the pitch surface of the gear and one on the pitch surface of the worm. The coefficient of friction varies very little at high rubbing speeds but rises with increasing rapidity as the speed drops below 500 fpm.

The efficiency formula developed in Figure 1 involves worm lead angle and the friction angle. Figure 2 provides a relationship between friction angle and rubbing speed based on tests made on accurately manufactured gearing consisting of hardened and ground worm and bronze gear operating in oil.

The formula for rubbing speed is:

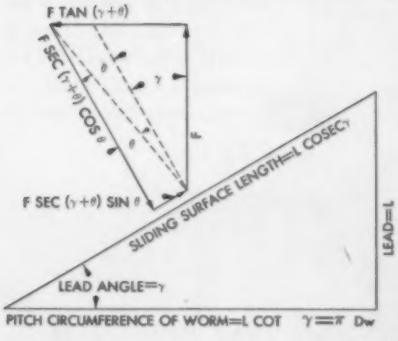
$$V = \frac{.262\ Dw \times \eta}{\cos \gamma}$$

where

$V =$ Rubbing speed – feet per minute
$Dw =$ Worm pitch diameter – inches
$\eta =$ Worm speed – rpm
$\gamma =$ Worm lead angle

FIGURE 1.

Development of equation for efficiency at contact between worm and gear


F TAN (γ+θ)
F SEC (γ+θ) COS θ
F SEC (γ+θ) SIN θ
SLIDING SURFACE LENGTH=L COSEC γ
LEAD=L
LEAD ANGLE=γ
PITCH CIRCUMFERENCE OF WORM=L COT γ=π Dw

F=TANGENTIAL FORCE ACTING ON GEAR

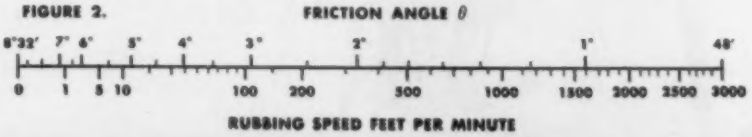
F TAN ($\gamma + \theta$) = TANGENTIAL FORCE APPLIED TO WORM

F SEC ($\gamma + \theta$) COS θ = FORCE NORMAL TO CONTACT SURFACE

F SEC ($\gamma + \theta$) SIN θ = FRICTIONAL FORCE

$$\text{EFFICIENCY} = \frac{\text{WORK REALIZED}}{\text{WORK APPLIED}} = \frac{L \times F}{L \cot \gamma \times F \tan (\gamma+\theta)} = \frac{\tan \gamma}{\tan (\gamma+\theta)}$$

FIGURE 2.



DE LAVAL Worm Gear Speed Reducers Offer Efficiencies to 96%

Ruggedly built for long efficient service De Laval speed reducers are made in horizontal and vertical single reduction units in ratios of 3:1 to 100:1. They are also available in double horizontal and vertical double reduction units as well as in helical-worm and double-worm design. Ratios from 37.8:1 up to 6400:1.

Write for your copies of Catalogs G-WBV and G-WWH to De Laval Steam Turbine Company, Trenton 2, New Jersey.

NOTHING *can equal Stainless Steel*

in its unique combination of properties

No other design material can match Stainless Steel in its unique combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. If you're looking for a reliable source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

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USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

USS

For Formability...

Jet engine and pressure vessel makers are using roll-formed rings in large numbers these days. Alloy Manufacturing Company in Pittsburgh is a major supplier of Stainless Steel fabricated parts, and they process this steel on ordinary "carbon steel rated" equipment without difficulty.

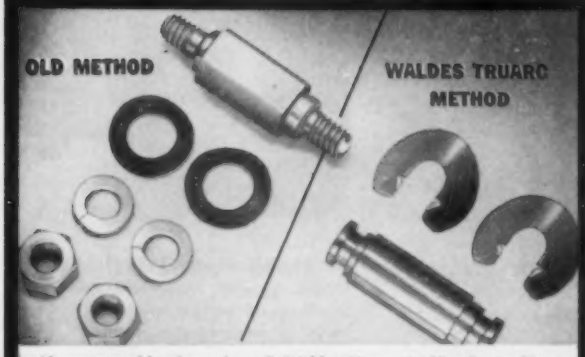
For Cleanliness...

Bates Manufacturing Company, Lewiston, Maine, is a famous name in cotton goods. They used to have trouble with dyeing equipment; the iron vats held the old colors and "killed" new colors. With Stainless Steel dye kettles, old colors actually *rinse* out, without costly scrubbing.

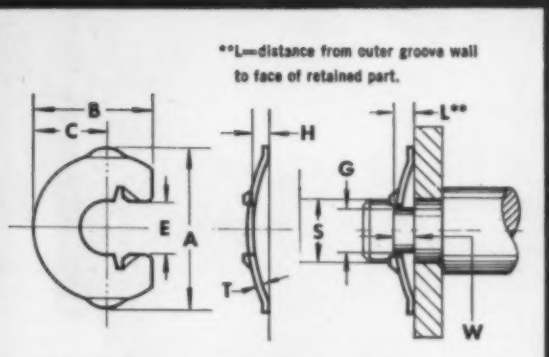
For Style...

G & G Woodcraft, Dinette Division, in Detroit, is selling a handsome new dinette table, designed by Gelitis, with a polished Stainless Steel top. The top is backed with plywood, and there is no metallic sound when it is struck. Stainless is a perfect material for contemporary design, and it's so *practical*.

New Waldes Truarc locking-prong ring functions as spring, shoulder, fastener... and STAYS PUT!



Above assembly shows how 2 Waldes Truarc Locking-Prong Rings (Series 5139) replaced 6 parts... eliminated threading operation... and need for skilled labor.



WALDES TRUARC LOCKING-PRONG RING (Series 5139)
U. S. Pat. Pending

Ring No. 5139-	SHAFT Dia. S	tol.	RING DIMENSIONS A	tol.	B	tol.	C	tol.	E	tol.	H	tol.	T†	tol.†	average ultimate shear strength lbs.*	GROOVE DIMENSIONS Dia. G	tol.	Width W	tol. — .000	L min.	L max.	resilient end play take up L max.– L min
12	.125	±.002	.340	±.010	.307	±.010	.166	±.005	.086	±.004	.050	±.010	.010	±.0013	400	.082	±.0015	.045	+.005	.035	.045	.010
★19	.156	±.003	.380	±.010	.330	±.010	.184	±.005	.108	±.004	.055	±.010	.010	±.0013	600	.104	±.002	.050	+.005	.035	.045	.010
18	.188	±.003	.445	±.010	.390	±.010	.213	±.005	.130	±.005	.060	±.010	.015	±.0015	900	.124	±.002	.065	+.005	.045	.055	.010
25	.250	±.003	.581	±.010	.500	±.010	.280	±.005	.172	±.005	.070	±.010	.015	±.0015	1000	.165	±.002	.070	+.005	.050	.065	.015
31	.312	±.003	.744	±.010	.620	±.010	.360	±.005	.234	±.005	.095	±.010	.018	+.001 −.002	1300	.228	±.003	.080	+.005	.080	.095	.015
★37	.375	±.003	.853	±.015	.740	±.010	.427	±.005	.280	±.005	.130	±.010	.020	±.002	1900	.270	±.003	.105	+.005	.090	.115	.025
★43	.438	±.003	.960	±.020	.820	±.020	.475	±.010	.337	±.010	.130	±.010	.020	±.002	2200	.327	±.003	.105	+.005	.095	.120	.025

Additional Sizes Under Development ★Production dies not available as of date of printing †Applies to unplated rings only *Recommended safety factor =3 to 4.

The Waldes Truarc Locking-Prong Retaining Ring is a new, low cost, radially applied fastener which can be locked positively in its groove and used as a shoulder against rotating parts. It is primarily intended for use in the automotive, electronic and aeronautical industries.

This radially applied ring locks positively in its grooves by means of two prongs at the open end. Because of its high thrust-load capacity the Waldes Truarc Locking-Prong Ring may be used as a shoulder against rotating parts. Its bowed construction provides for end-play take-up in the assembly and makes less critical the tolerances required for the parts being fastened. Since it serves as a spring as well as a shoulder, this ring eliminates the need for springs, washers, and other accessory fastening devices.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Locking-Prong Rings. (please specify shaft size_____)

☐ Please send me supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

Name_____

Title_____

Company_____

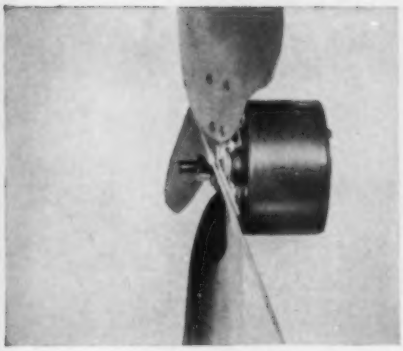
Business Address_____

City_____ Zone_____ State_____

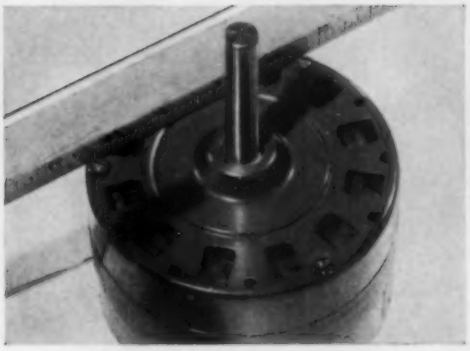
PNO40

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.

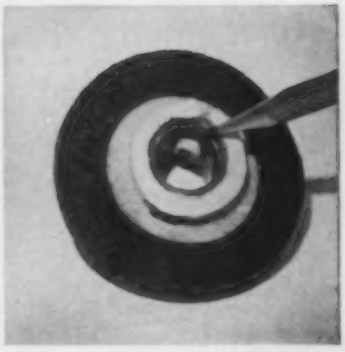
SMALLER DIAMETER and shorter length of this new motor make it possible to design compact, better looking, more salable products. Also speed installation, cut shipping costs and stocking space requirements.



MOUNTING CONVENIENCE—choice of either flush mounting with extended through-bolts (2, 3, or 4) or resilient mounting—helps solve design problems. Bearing construction permits all-angle operation.



PRECISION BRACKETS of heavy-gauge, drawn steel reduce motor length . . . provide quieter operation and longer life. Flat, circular area around through-bolts makes flush mounting possible—much easier.



NEW LUBRICATION SYSTEM with larger oil capacity circulates oil through filtering wicks . . . assures positive oil film between bearings and shaft plus quieter, cleaner, cooler—more economical—operation.

New motor goes on a diet to help streamline your products

More compact Westinghouse shaded-pole motor designed for today's modern air-moving equipment

Here, in a compact package smaller in diameter than conventional designs and no longer than a cigarette, Westinghouse has combined these benefits for you—lower costs, easier installation, minimum air-movement restriction, and longer, trouble-free operation.

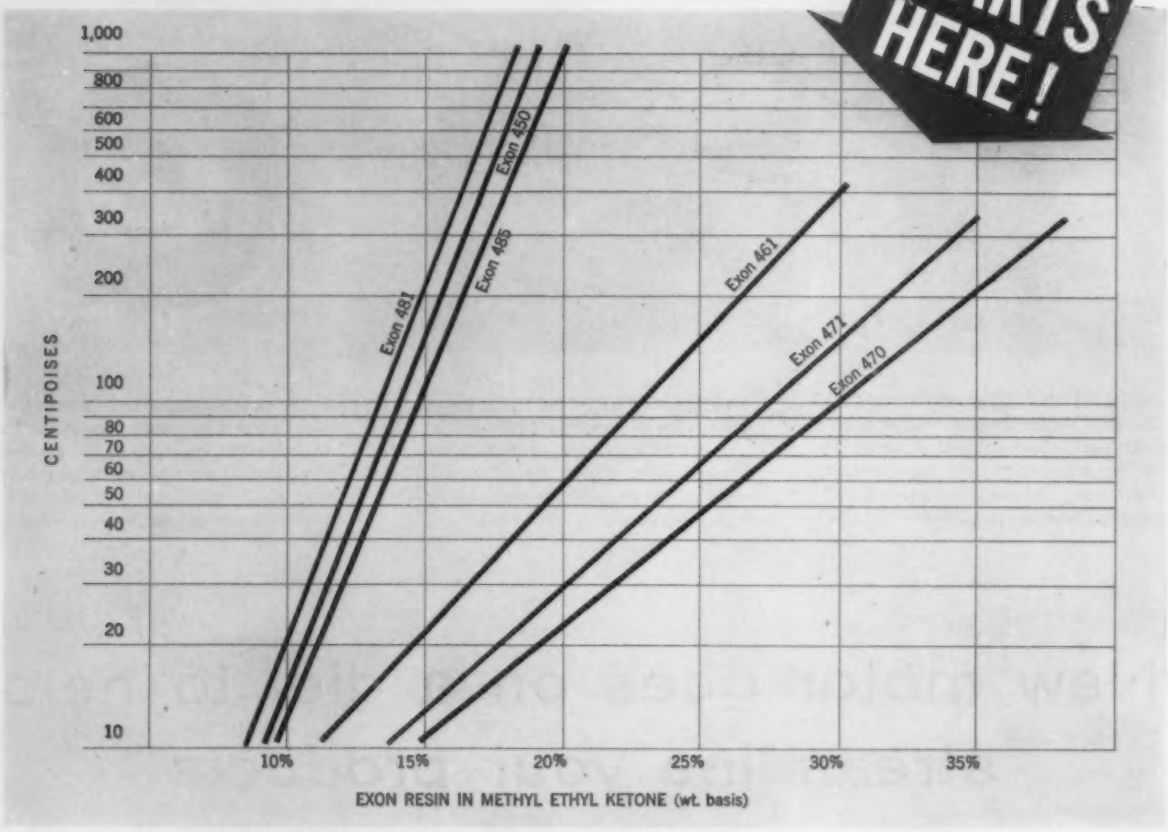
Whatever your product—room air conditioners, ventilating fans, unit heaters and coolers, furnace blowers or the like—you will find new opportunities to cut costs, streamline your product and increase its salability with a new Westinghouse shaded-pole motor.

For more information on the new Westinghouse shaded-pole or permanent split-capacitor motors, contact your nearby Westinghouse sales office. Or, write Westinghouse Electric Corporation, Small Motor Division, P. O. Box 566, Lima, Ohio. J-03031-X

YOU CAN BE SURE...IF IT'S

Westinghouse

SUCCESS IN COATINGS STARTS HERE!



EXON CHARTS SOLUBILITIES to help you choose the resin with properties Pin-Pointed to your special needs!

EXON 450 Ideal for strip coatings. Good solubility, tensile strength and durability.

EXON 461 A unique fluorine-containing resin combining high solubility, unusual chemical resistance, heat stability and weatherability.

EXON 470 Excellent adhesion to metals, alkyd and vinyl surfaces. Compatible with wide range of drying oils, alkyds, phenolics, melamines. High solubility in inexpensive solvents.

EXON 471 Excellent for weatherability and durability in a protective coating. Corrosion resistant. No measurable change after sunlamp exposure for 360 hours as 1 mil film.

EXON 481 Makes possible colorful, abrasion-proof, washable coatings that resist fading or cracking.

EXON 485 For superior strip coatings. Lower viscosity makes application easier and shelf-life better. Good clarity.

Firestone EXON RESINS

THE special nature of Exon resins — "Pin-Pointed Properties" to supply specific answers to special needs —is particularly desirable in the manufacture of coatings.

Because products and processes vary, Firestone Exon has engineered 6 solution resins to help you formulate a successful coating. Each resin differs in properties, such as the solubility factor charted above, to suit various applications.

One property in common: superior quality of performance with the resultant production speed and savings which have made Firestone Exon industry's No. 1 source of specifically engineered vinyl resins.

We suggest you keep this chart handy—to help you put your finger on the right resin for *you* — at a glance.

For complete information and technical service, call or write:

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FIRESTONE PLASTICS COMPANY, DEPT. 76F,
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A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.

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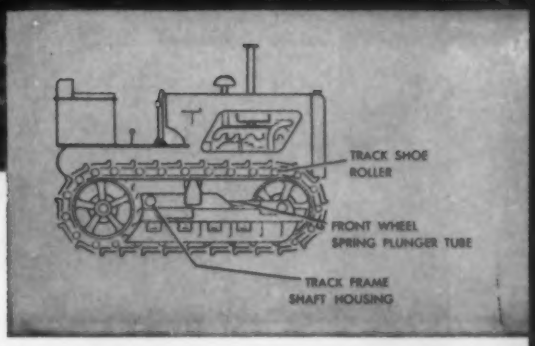
INDUSTRY'S MOST COMPLETE LINE OF VINYLS ENGINEERED TO YOUR SPECIFIC NEEDS



For top performance and long service

this rugged Tractor relies on machine parts of

SHELBY SEAMLESS TUBING

In this powerful Oliver OC-12 Bulldozer, the following parts are fabricated from Shelby Seamless Mechanical Tubing — track shoe rollers, front wheel spring plunger tubes, and the track frame shaft housing. The chief qualifications possessed by these parts are high strength and superior wearability . . . qualities that are just right for a heavy-duty tractor application.

Super-rugged equipment calls for super-strong materials. That's why you'll find USS Shelby Seamless Mechanical Tubing being used for so many tractor applications. Its great strength, complete uniformity, and extreme dimensional accuracy make Shelby Seamless the ideal mechanical tubing for the fabrication of machine parts subject to bruising performance and long wear.

Available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, Shelby Seamless Mechanical Tubing is produced to exacting standards by the world's largest manufacturer of tubular steel products. Contact our engineers for recommendations. They will welcome the opportunity to help you apply Shelby Seamless to your specifications.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

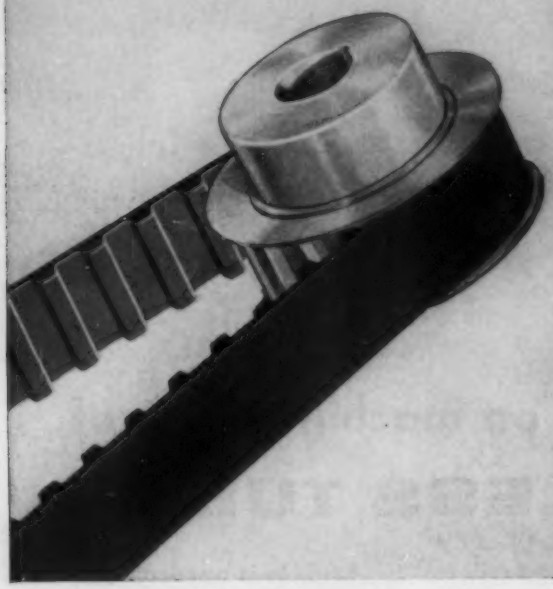
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

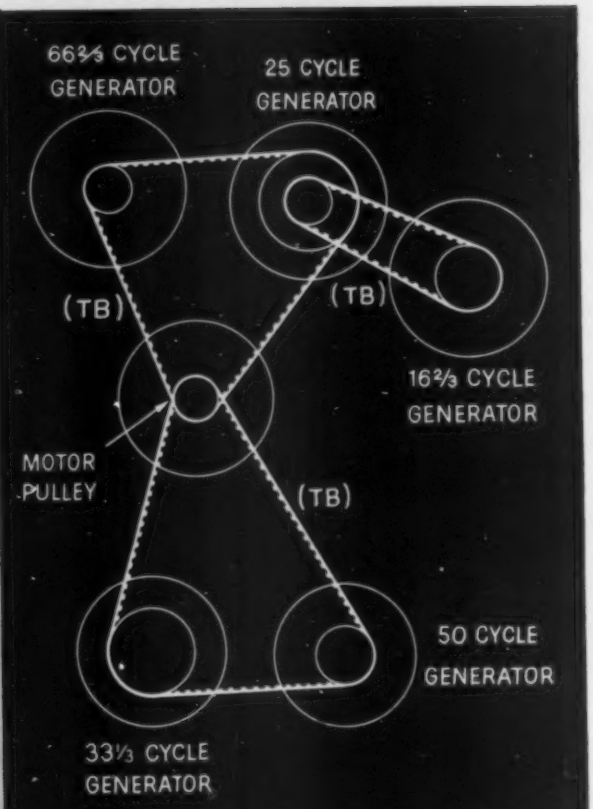
USS **SHELBY SEAMLESS MECHANICAL TUBING**

UNITED STATES STEEL

PowerGrip "TIMING" BELTS

Making one motor do the job of five





Above is a schematic drawing of a 5-frequency telephone ringing unit on a party-line system. Previously, five motors were needed to generate the different ringing frequencies. But with the installation of just *three* U.S. PowerGrip "Timing" Belts (TB) *only one motor is needed* now. That's because U.S. PowerGrip provides a positive, non-slip grip that preserves the exact speed ratios and the synchronization needed to maintain critical frequencies. And there is absolutely no measurable power loss.

This is one more example of the U.S. PowerGrip "Timing"® Belt's ability to simplify and improve a power transmission unit . . . one of the reasons why the invention of U.S. PowerGrip "Timing" Belt was recently awarded the Franklin Institute's Edward Longstreth Medal for "Invention of High Order."

Whether it's for the design of hand tools, lathes, drill presses, saws, electric typewriters—from fleapower to horsepower—U.S. PowerGrip offers all these advantages:

- *no slippage, no take-up—allows short centers, high ratios.*
- *absence of metal-to-metal contact—eliminates need for lubrication and housing devices.*
- *handles speeds up to 16,000 F.P.M. or so slow as to be imperceptible to the eye.*
- *close to 100% efficiency.*
- *imbedded with steel cables for high tensile strength*
- *constant angular velocity.*

These belts—plus expert engineering service—are obtainable at "U.S." power transmission distributors, at any of the 28 "U.S." District Offices, or by writing us at Rockefeller Center, New York 20, N. Y.

Mechanical Goods Division

United States Rubber

ANOTHER PUMP PROBLEM...SOLVED BY **TUTHILL**

Operates from -65° to 130° F

SUN ELECTRIC'S

Aircraft Hydraulic Systems Tester with

TUTHILL PUMPS

The Model AHT-30-A Sun Aircraft Hydraulic Systems Tester, shown here, has a tough assignment. Designed to simultaneously test in the field the hydraulic systems on two jet aircraft, without operating the aircraft engines, the tester must function under rugged operating conditions. For example, it must operate at temperatures from —65°F to 130°F...at altitudes from sea level to 6000 feet...at relative humidities from 95 to 100%.

These unusual operating conditions obviously dictate the choice of a special and unusual hydraulic fluid. The fluid finally selected met all requirements but had one drawback—it was tough on hydraulic pumps.

Like many others, Sun's engineers found the answer to their pump problem at Tuthill. A special modification of Tuthill's Model 4CB pump provided the backbone for the two separate hydraulic systems in Sun's Tester. The Tuthill pump is used to supply booster service by supercharging on the suction side of a standard high-pressure hydraulic pump. This combination allows the Sun Tester to deliver hydraulic fluid at the rate of 20 gpm at a pressure of 3000 psi through either or both of its two independent hydraulic systems.

Model CB, used in the Sun Tester, is a compact, dependable, self-priming, positive displacement pump with a special Tuthill mechanical shaft seal and built-in ball bearings, designed for directional operation. With an economical first cost, it requires negligible maintenance resulting in extremely low operating costs.

Model CB may provide the answer to your pump problem—or one of the other 750 models in the Tuthill line may supply your needs. If your requirements can not be met by one of our standard models, Tuthill engineers will work with you in developing a modification for your particular application.

If you have a pump problem, your Tuthill representative probably has the answer. Why not call him today?

TUTHILL PUMP COMPANY
961 East 95th Street, Chicago 19, Illinois
Gentlemen:
☐ Please send me information on the Model C Series
☐ Please send information on the complete Tuthill line.

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Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities from 1 to 200 GPM, for Pressures to 600 PSI, Speeds to 3600 RPM.

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1. CYMAC 400 Polymethylstyrene—offers unusual heat resistance *plus* all the desirable properties of polystyrene, including excellent electrical properties, clarity, luster, and unlimited range of transparent and opaque colors.

2. CYMAC 201 Methylstyrene-Acrylonitrile Copolymer—offers better toughness, chemical and craze resistance than CYMAC 400—*plus* heat resistance, clarity, luster, and wide color range.

Both of these new molding compounds provide the added value of remarkable heat resistance at costs no greater than competitive materials.

These new methylstyrene thermoplastics are made possible by revolutionary new processes developed by Cyanamid. They will help you upgrade existing molded products, and find new applications in consumer and industrial fields.

Turn opportunity into reality NOW. Write or call today for complete information and samples.

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For refrigerator parts

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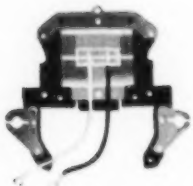
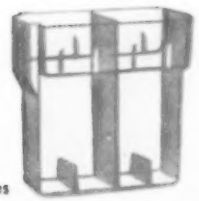
For pen barrels



For electrical parts

For fan blades



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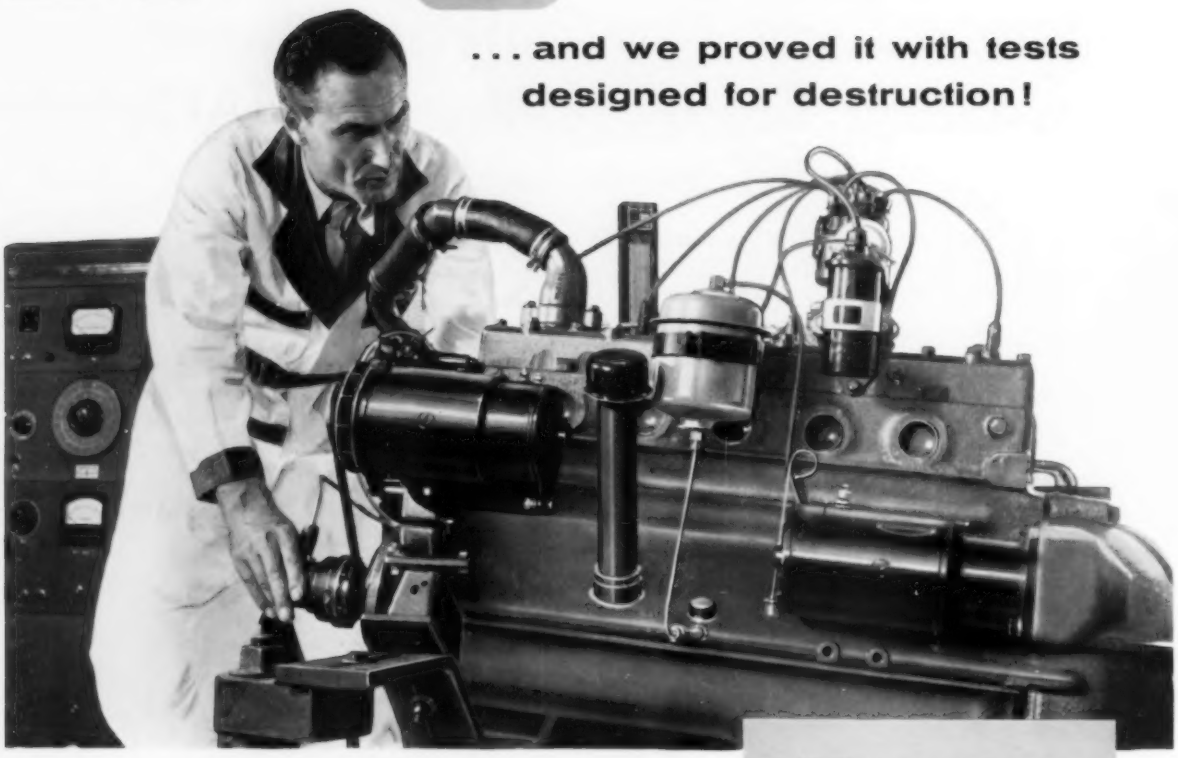
For wall tiles

. . . and hundreds of other products

RUGGED

. . . and we proved it with tests designed for destruction!



WE pummeled the new Heavy Duty 'Jeep'-6 on the rack, in one high-speed torture test right after another. But we couldn't break this baby!

Each rugged test was the equivalent of 50,000 vehicle miles. Results after repeated tests: no breakdowns . . . no parts failures!

AND YOU GET NEW LUGGING POWER

New high torque gives you the extra lugging power you need when your equipment meets heavy loads at low rpm. Write today for full details and prices.

Also rugged Jeep 4 cyl. Industrial Engines and Power Units

'Jeep'-6 SPECIFICATIONS

Continuous duty torque
1200-2600 rpm . . .
143-132 ft. lbs.
(peaks at 1200 rpm)

Continuous horsepower
1200-2600 rpm . . .
33-65 maximum*
***with accessories**

WILLYS MOTORS, INC. *Industrial Engine Dept.* **Toledo, Ohio**

Weight-saving Welded Carbon Steel Tubing provides strength and resistance to stresses in all directions in nine mechanical functions of this cutter bar attachment. If it *moves*, use Welded Steel Tubing.

The economy of Welded Stainless Steel Tubing subjected to high temperatures and corrosive atmospheres is exemplified in the jet nozzles of this industrial furnace over-fire system.

Only WELDED Tubing serves so well!

CARBON · ALLOY · STAINLESS STEEL

First of a series

Only *WELDED* Tubing, carbon, alloy or stainless steel, can answer so many requirements of the designer so economically. If the part *moves*, revolves, telescopes or bears weight, only welded tubing's consistent uniformity fills the bill. If in addition, corrosion-resistance, heat-resistance, freedom from contamination or lasting strength and beauty are your criterions, only welded stainless steel tubing fills *all* your requirements.

See your quality tube producer for specific information pertinent to your requirements.

FORMED STEEL TUBE INSTITUTE

Design Inspiration for you

Screen this 26-minute motion picture about Welded Tubing and its design advantages. Give alternate screening dates—on your letterhead, please!

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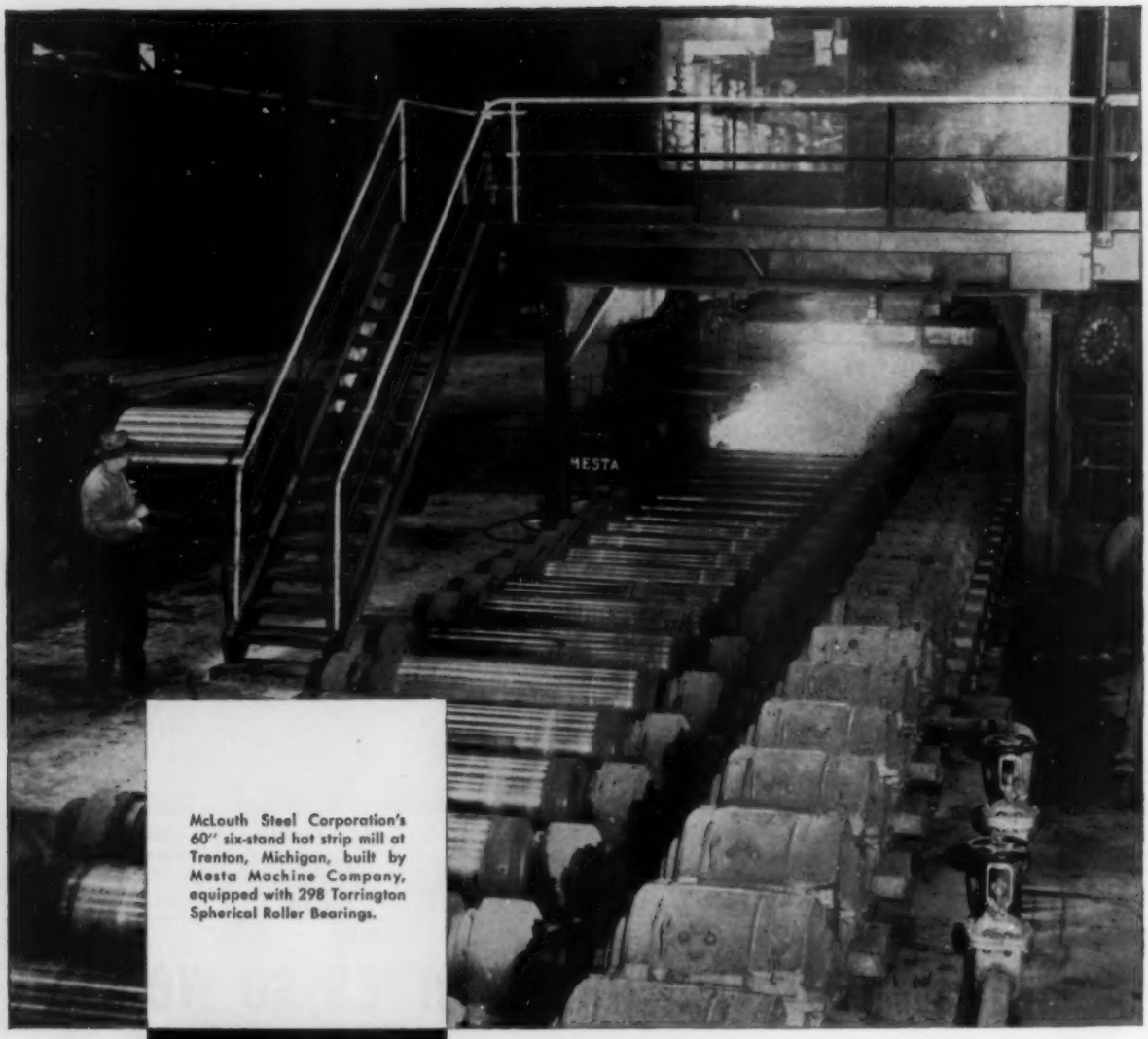
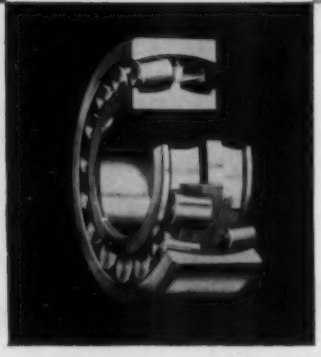
An Association of Quality Tube Producers



McLouth Steel Corporation's 60" six-stand hot strip mill at Trenton, Michigan, built by Mesta Machine Company, equipped with 298 Torrington Spherical Roller Bearings.



Self-driven table rolls mean drastic cut in mill down time!

It was a new idea. Suppose mill approach and runout table rolls had their own independent motors and pillow blocks instead of conventional gearing and line shafts? Then any roll could be removed for maintenance and replaced immediately by a stand-by assembly without shutting down the whole table for hours!

Torrington engineers, working with Mesta engineers, came up with a design mounting Torrington Spherical Roller Bearings in Torrington-built fixed and floating pillow blocks. These bearings compensate for misalignment across the table and for dynamic deflection of the rolls under load. In both roughing and finishing mill tables, 298 Torrington Spherical Roller Bearings have been operating efficiently since 1954!

The Torrington Company, with experience in the manufacture of every major type of anti-friction bearing, has made thousands of installations in steel mill equipment that have helped roll record tonnages. Your Torrington engineer is an expert: call on him when you need help. *The Torrington Company,* South Bend 21, Ind. — Torrington, Conn.

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CONTROL?

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On America's leading tractors, Webster Hydraulic pumps have proven themselves a winner. They stand up better to such tough, demanding day after day abuse. When your hydraulic application calls for proven stamina to resist shock, with a reserve of quick response and compactness of overall design . . . be it for farm equipment or power shovels, then the man from Webster can help. Let him tell you about the complete Webster line of over 100 different positive displacement gear type pumps and fluid motors.

Write or call the man from Webster — a good man to have on your design team.

OIL HYDRAULICS DIVISION
WEBSTER ELECTRIC
MELROSE 3-3511
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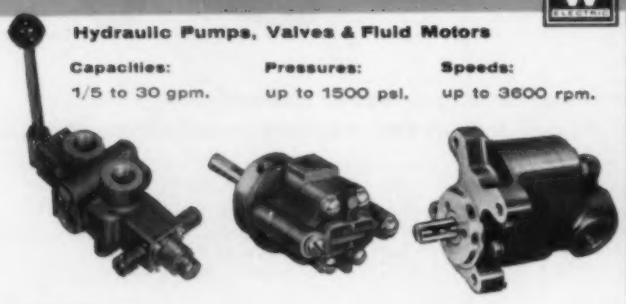
Hydraulic Pumps, Valves & Fluid Motors

Capacities:	Pressures:	Speeds:
1/5 to 30 gpm.	up to 1500 psi.	up to 3600 rpm.



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Quality control isn't a myth— it's a crusade!

At National, quality control is based on the oil seal industry's most rigid manufacturing specifications. It begins with critical examination of raw materials. It includes constant checking of form tools and molds. It extends to exhaustive optical examination of all seal components by an exclusive process developed at National. (In this process, seals are cast and cross-sectioned, and an optical comparator used to show exact shape and position of every seal part, mounted on the shaft or unmounted.) And always, there are extensive and continuing operating and "leak" tests of finished seals.

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NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

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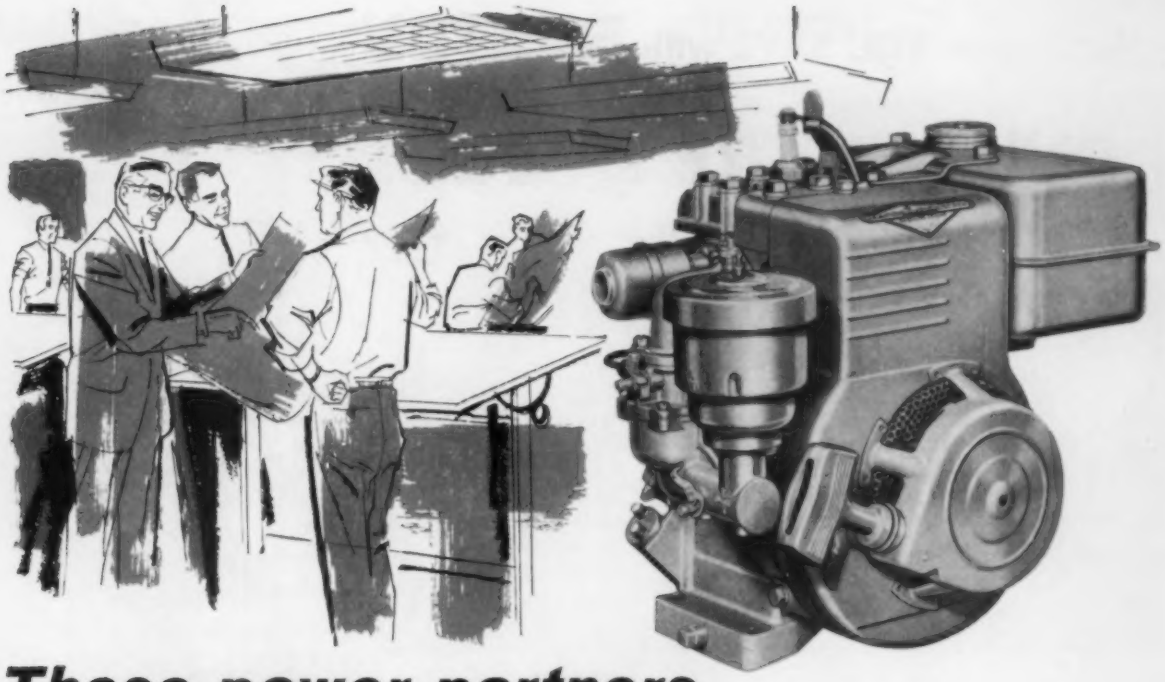
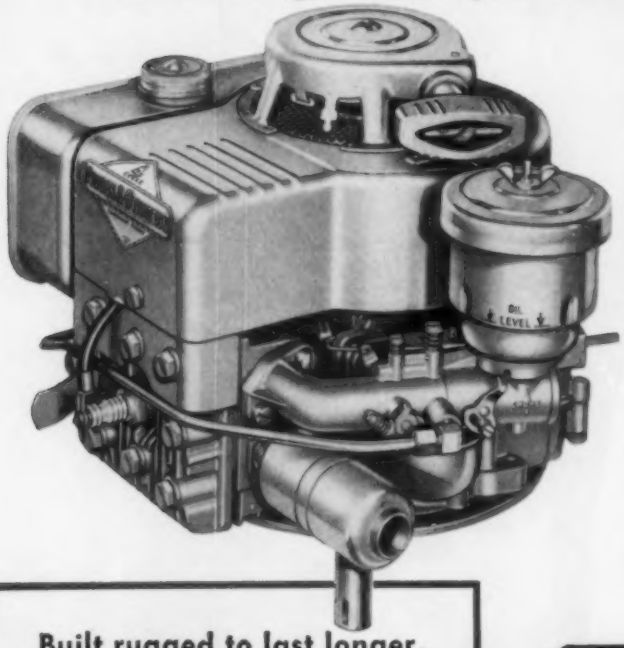


These power partners make great products even better



Briggs & Stratton 4-CYCLE, single-cylinder engines are known and demanded by users everywhere . . . because millions of these *power partners* are delivering trouble-free performance under all operating conditions.

And they are available in a wide range of models and ratings—and a choice of accessories. Thus, you will find the right *power partner* for your product in the Briggs & Stratton line.

What's more, when you're contemplating the application of a gasoline engine to your product, you can utilize Briggs & Stratton's consulting engineering service. Result: You may save time, money and modification headaches.

To further protect your product's good name, Briggs & Stratton maintains a world-wide network of over 9,000 authorized service outlets.

Built rugged to last longer, perform better — weighs less

Air-Age engineered — proved by millions of engines on countless products for home, farm and industry. Built to provide the quick starts and smooth-running power for tough going that have made Briggs & Stratton 4-CYCLE engines *No. 1 in use throughout the world.*

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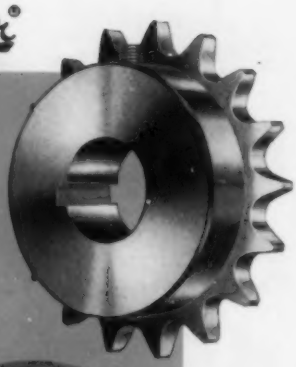
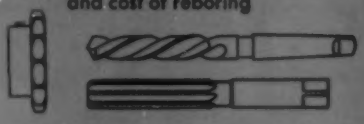
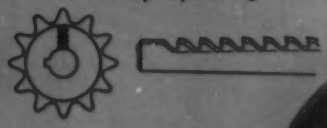
complete with keyway and set screw . . . ready to install



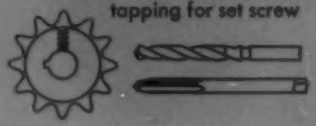
YOU SAVE time and cost of reboring



YOU SAVE time and cost of keyway cutting



YOU SAVE time and cost of drilling and tapping for set screw



YOU SAVE delay and cost of downtime in emergencies

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Your Boston Gear Distributor can deliver promptly any size and bore you need from the full selection of 321 different pinions on his BORED-TO-SIZE SPROCKET stock rack.

Why "do-it-yourself" . . . at double the cost? Select the sprocket you need FROM STOCK, and get Boston Gear precision, finish, and performance that assures longer service life for both sprocket and chain. See Catalog No. 56 for complete listings — and other Boston Gear Sprockets to meet any drive need. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

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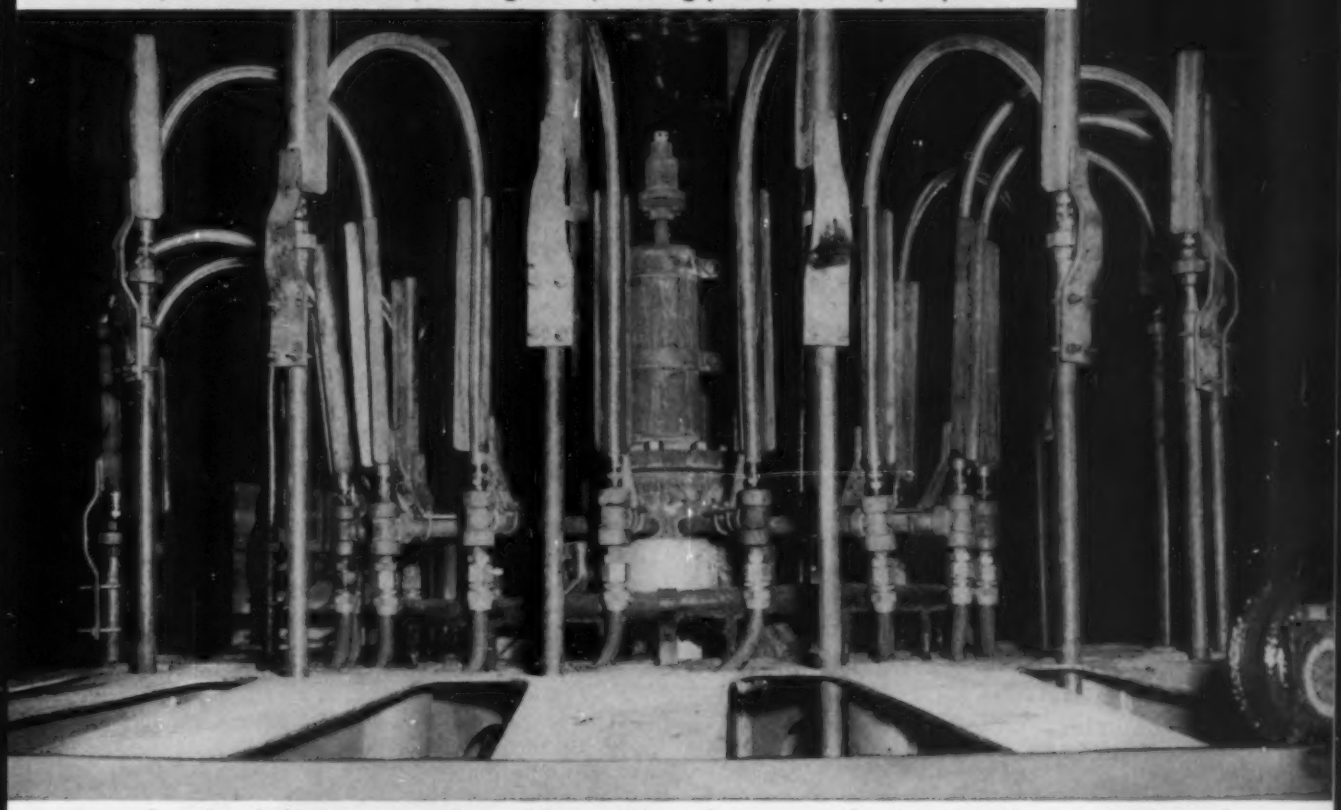
For nearest Distributor, look under "GEARS" in the Yellow Pages of your Telephone Book.

Where you convey steam

and have problems of vibration, misalignment, moving parts, or cramped space.



LIVE STEAM flows through this American stainless steel hose at 230 pounds per square inch at 390°F. Hose flexes over 100 times an hour.

You get absolutely "tight" conveyance—under high or low temperatures and pressure—with American Flexible Metal Hose!

Live steam "on the loose" can be costly . . . and dangerous. That's the problem facing the Diamond Match Company. The job: conveying live steam around a 180° bend . . . in a conveyor which must undergo continuous flexing.

Many lines were tried—and failed. American stainless steel hose was finally suggested, and is now doing the job! This is not unusual. American flexible metal hose has a long record of peak performance in the field.

It absorbs vibration and prevents its transmission to surrounding structures . . . absorbs expansion and contraction in lines due to temperature changes . . . facilitates installation, especially in cramped spaces . . . and solves the problems of misalignment.

Available in wide range of diameters in tough bronze, steel, super nickel, brass, stainless steel and other metals, American flexible metal hose delivers the very highest service hours per dollar. American furnishes flexible metal connectors to your specifications . . . ready for immediate installation.

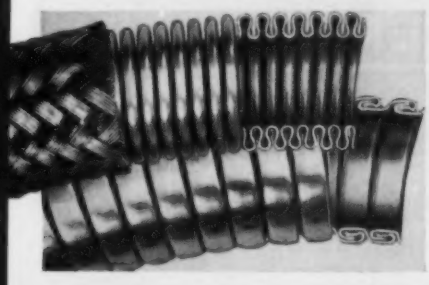
Consult your nearby American Metal Hose representative for engineering help when planning your next job. No obligation. See American Brass Company or Anaconda in your phone book—or write: American Metal Hose Division, American Brass Company, Waterbury 20, Conn.

86178 Rev.

WHEREVER CONNECTORS MUST MOVE

AMERICAN FLEXIBLE METAL HOSE AND TUBING

AN **ANACONDA®** PRODUCT



BASIC TYPES

Seamless corrugated and Strip-wound. Both types available in a wide range of sizes and styles in any workable metal. Furnished with or without end fittings attached.

THE AMERICAN BRASS COMPANY
American Metal Hose Division, Waterbury 20, Conn.

Please send me a free copy of your new flexible metal hose and tubing catalog, G-560.

NAME & TITLE.....

ADDRESS.....

COMPANY.....

CITY, ZONE, STATE.....

What do Machine Builders like most about SQUARE D's New Machine Tool Relays?... SMALL SIZE!

Class 8501
Type DO-22

No wonder the welcome mat is out for these new 10-ampere, 600-volt relays. You've always had a warm spot in your heart for COMPACTNESS... and here it is! Let the dimensions speak for themselves—

2-pole Type DO-22 *(at left)* measures 3 5/16" high x 2 5/8" wide!

4-pole Type DO-42 *(below)* measures 3 11/16" high x 2 13/16" wide!

But that isn't all. You take these relays apart, in 20 seconds, *from the front.* No "tear down" space is needed—absolutely none!

Small size isn't the only reason machine tool builders welcome these new relays. Anything that's good for their customers is good for them—so they're not overlooking advantages like those shown on the opposite page. After all, there's something mighty satisfying about the customer's nod of approval when he sees the time-proven D nameplate on the relays that help control his new machine.

Class 8501
Type DO-42

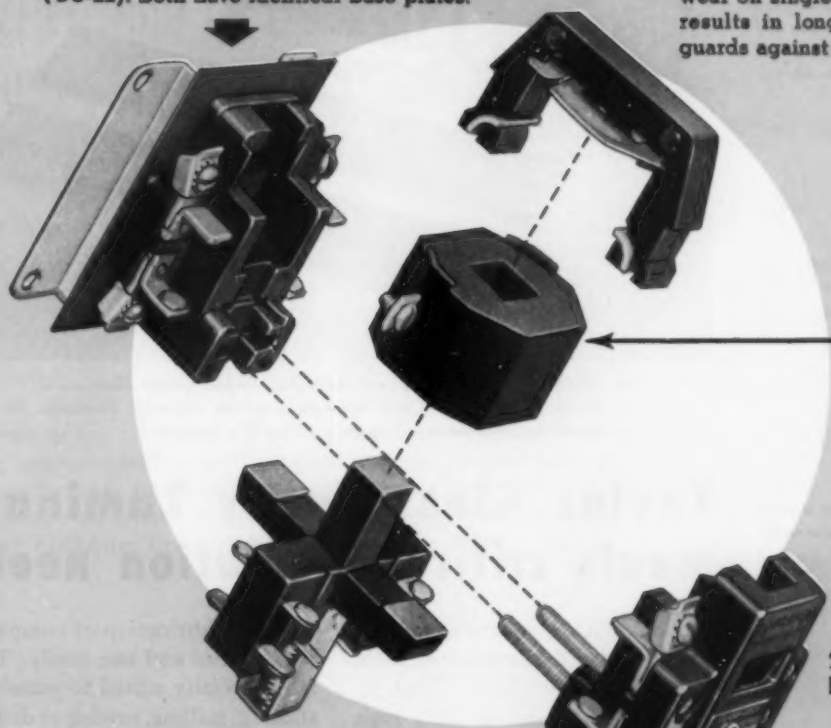
NOW... EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

And these 4 Advantages make real sense to the men who *BUY* and *USE* the machines!

NO MOUNTING WORRIES
When more contacts are required, the 4-pole relay (DO-42) can be substituted for the 2-pole (DO-22). Both have *identical* base plates.

OUTSTANDING PERFORMANCE
Balanced construction reduces wear on single moving part... results in long life and safeguards against down time.



RESISTS DAMAGE
Plastic impregnated molded coil is unbreakable, operates cooler, is dimensionally stable and impenetrable by water and oil.

20-SECOND DISASSEMBLY
Simply loosen two screws and the entire device is disassembled for normal maintenance.

Packaged Parts Kits make normal maintenance easier than ever. Any way you look at it, these new relays are tops. Small in size—long on features and performance.

For the complete story, write for Bulletin 8501. Address Square D Company, 4041 North Richards St., Milwaukee 12, Wisconsin.

Everybody's Ahead with Square D!

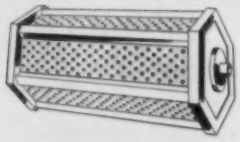
TAYLOR Shop Talk

Laminated Plastics
Vulcanized Fibre

TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

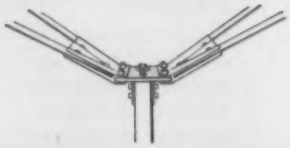
PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

Tips for designers



"Metal-plating barrels" of Taylor Grade C-5 melamine withstand corrosion and erosion successfully in alkaline solutions. Downtime and maintenance costs are substantially reduced.

Self-retaining grommets cut from Taylor phenolic tubing shield cables and wires passing through bulkheads . . . offer good electrical insulating properties.

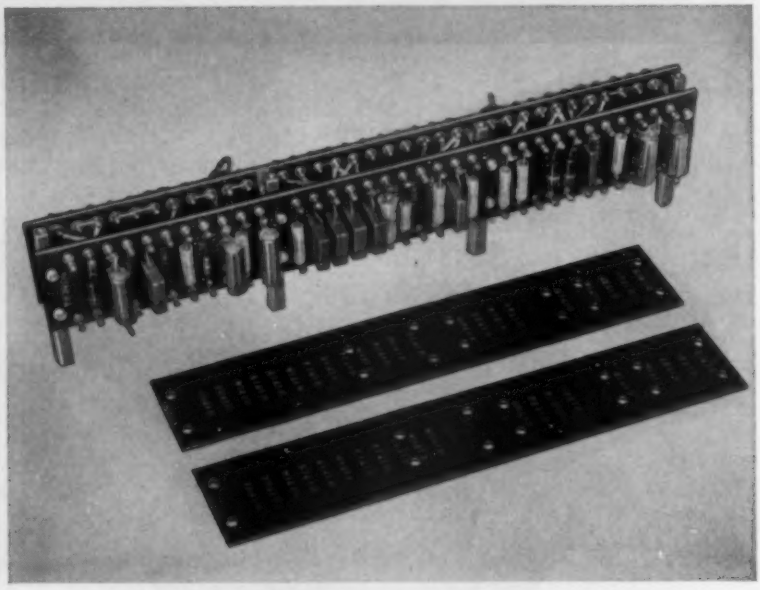


Insulation support of TV antenna rods is made of Taylor laminated phenolic which assures dependable, moisture-resistant insulation . . . is unaffected by weather.

Identification tag, easily fabricated from Taylor super-white vulcanized fibre, is non-abrasive and non-corrosive, can be printed and has safe, non-cutting edges.

NEW TAYLOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



Six resistor board assemblies on the new Martin Matador guided missile are of Taylor Grade GEC (glass epoxy) laminate, chosen for this tough application because of its stable electrical properties and humidity resistance.

Taylor Glass Epoxy Laminate meets critical insulation needs

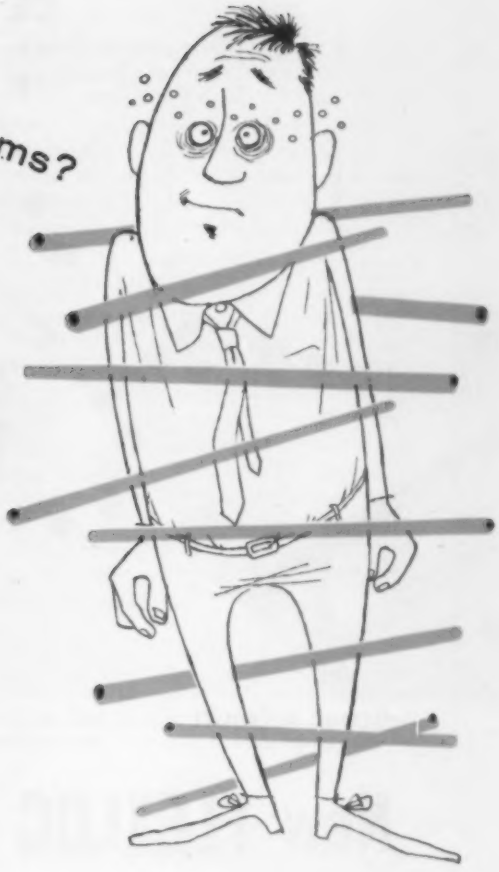
Taylor GEC (glass epoxy) meets the Matador's exacting electrical insulation requirements. These requirements consist of . . . high strength to withstand the G's . . . low moisture absorption to withstand the varying humidity and temperature . . . electrical and mechanical stability. Your requirements, which are no doubt different, may be equally exacting. Taylor's wide range of laminates include that combination of electrical, mechanical and chemical properties that you require.

Designed for ease of fabrication . . . Taylor laminates are the result of resin formulations and production techniques developed to make fabrication of completed parts easier and less costly. They are especially suited to punching, staking, milling, sawing or drilling when accurately sized parts are a must.

When specifications call for stability, specify Taylor laminates. They maintain their original characteristics over long periods of time and under rugged operating conditions.

To help you in your selection of a laminate, Taylor's engineering staff and fabricating facilities are at your service. Contact your nearest Taylor sales engineer for a discussion of your particular requirements.

Up to here in tubing problems?



EVERY INCH OF GM STEEL TUBING MUST PASS AN EXCLUSIVE HIGH-PRESSURE "PLUS" TEST!

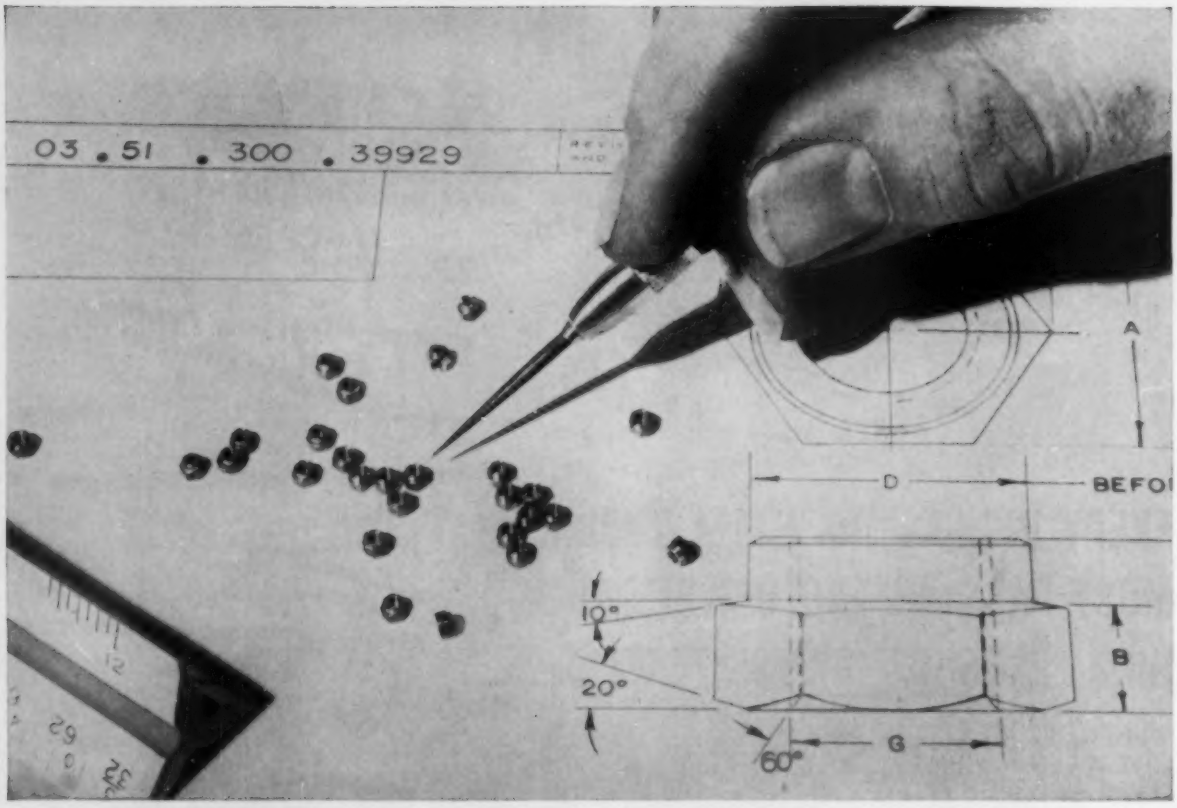
When you specify GM Steel Tubing, you get the toughest, most dependable refrigeration tubing made. Every inch of GM Steel Tubing must withstand an exclusive high-pressure hydrostatic test, under conditions far more demanding than any it will ever meet in actual use.

Worried about welds? Tests prove that the weld on every piece of GM Steel Tubing approved for shipment is as strong as the steel itself. What's more, four separate cleaning processes and inspections guarantee the cleanest tubing you can buy. For further information on how GM Steel Tubing can better meet your tubing problems, contact your Rochester Products Sales Engineer or write us direct.

Only GM Steel Tubing undergoes this extreme test of high-pressure solvents to assure maximum strength and cleanliness.

GM STEEL TUBING BY ROCHESTER PRODUCTS

Rochester Products Division of General Motors, Rochester, N. Y.



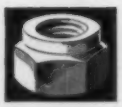
FLEXLOC MICROSIZE locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

New FLEXLOC Microsize Locknuts

Now available in Alloy Steel, Stainless Steel, Brass and Aluminum for lighter, more compact designs

SIZE	Across Flats		Hex. Height	Across Corners	Height
	MAX.	MIN.	REF.	MIN.	REF.
0-80 NF-3B	.111	.107	.046	.121	.075
1-64 NC-3B	.127	.123	.056	.140	.090
1-72 NF-3B	.127	.123	.056	.140	.090
2-56 NC-3B	.158	.153	.067	.176	.105
2-64 NF-3B	.158	.153	.067	.176	.105
3-48 NC-3B	.190	.183	.071	.210	.120
3-56 NF-3B	.190	.183	.071	.210	.120
4-40 NC-3B	.190	.183	.071	.210	.120
4-48 NF-3B	.190	.183	.071	.210	.120

SPECIFICATIONS: Available in brass (plain or cadmium plated) and aluminum (plain or chemically treated), for temperatures to 250°F; in alloy steel (plain or cadmium plated) and 18-8 stainless steel (silver plated) for temperatures to 550°F.



New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

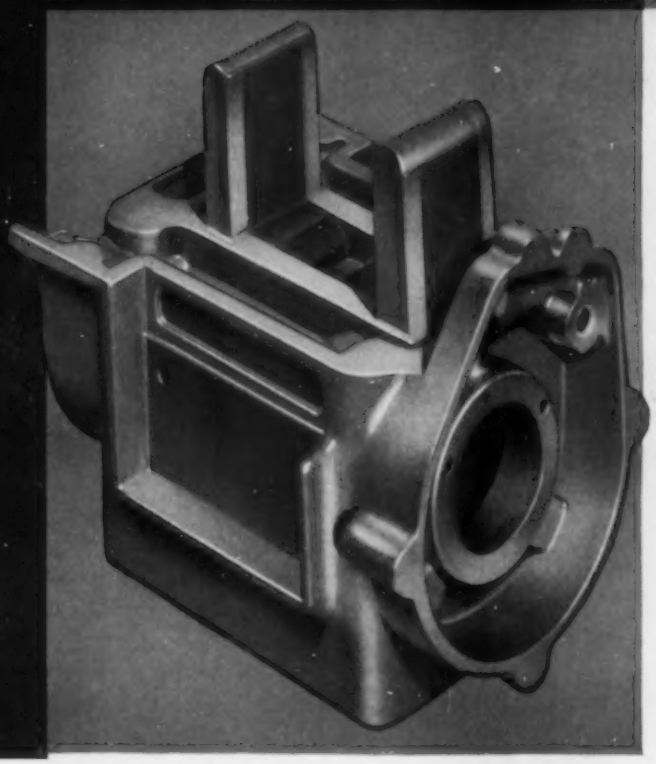
Microsize FLEXLOCS have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil won't affect these Microsize FLEXLOCS. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on Microsize FLEXLOCS, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA



Problem: To produce a rugged, one-piece, weatherproof magneto frame for International Harvester farm tractors. Five separate magneto parts must be incorporated into the body of the casting, and accurately positioned to meet exacting tolerances of the final assembly. Must be designed for fast, economical production.

Solution: Working closely with IHC, Stewart Die Casting engineers developed a "slide die" consisting of an elaborate system of cores, slides and positioners. This intricate arrangement holds the two magnetic field pieces, the two magnetic pole pieces, and the bearing race in exact position while the metal is injected around them in the die. The result was a precision casting that can be produced economically with a minimum of rejects, and give dependable performance under all conditions.

Stewart found the solution and made delivery on time!

This is just one of many complicated die castings that Stewart has developed promptly . . . and produced in quantity *at low cost.*

Nearly half a century of experience, plus unexcelled production facilities, enables Stewart to offer fast, practical solutions to any die casting problem.

Whatever type of die casting you need— large or small, simple or intricate — you can count on Stewart for a quality job . . . delivered on schedule!

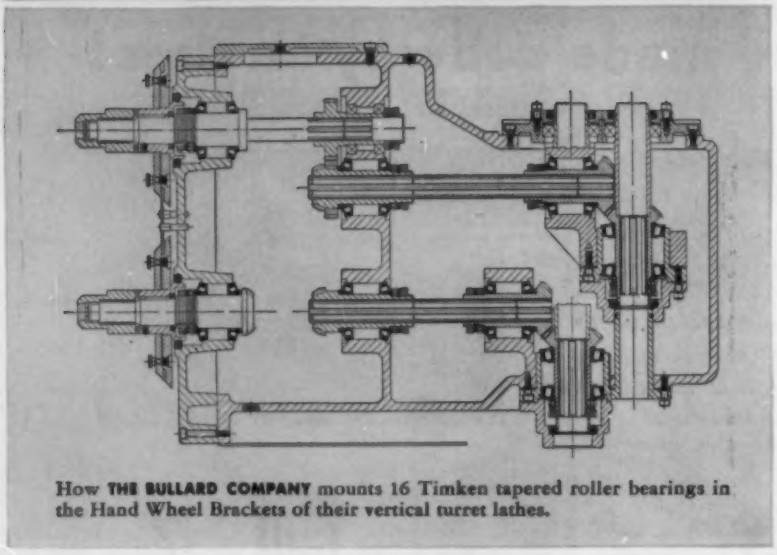
Stewart DIE CASTING

Division of STEWART-WARNER CORPORATION

Chicago, Illinois: 4535 Fullerton Avenue • Bridgeport, Connecticut: 275 Warren Street

46 YEARS OF SERVICE TO INDUSTRY

TIMKEN® bearing equipped . . . 1 lathe replaces 4, cuts machining time 81%



How **THE BULLARD COMPANY** mounts 16 Timken tapered roller bearings in the Hand Wheel Brackets of their vertical turret lathes.

THIS new Bullard 36" Cut Master Vertical Turret Lathe, turning out hub discs and cover discs for turbo wheels at the York Corporation, York, Pa., has cut machining time an average of 81%. And does all the operations formerly done on 1 horizontal turret lathe, 2 engine lathes, and 1 older vertical turret lathe! Timken® tapered roller bearings play a major role in this production story.

16 Timken bearings in the hand wheel bracket—and other Timken bearings in the headstock and feed works—maintain precision, locate shafts and gears, hold integral parts in accurate alignment. Reduce wear.

Maintenance costs are low, with Timken bearings built to last the life of the lathe. Friction is practically eliminated, conserving power. Timken bearings are geometrically designed, precision-manufactured, to give *true rolling motion.* To insure highest quality, we even make our own fine alloy steel—which no other American bearing maker does.

Look for the trade-mark "Timken" on each bearing! The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.

...improved performance with Westinghouse insulating materials

Proven in over 100 Million Applications
And here's what they can do for you . . .

The Westinghouse line of flexible insulating materials satisfies *every* electrical insulating need. More important, this complete line of flexible insulation, tapes, resins and varnishes has been proven in over *100 million* original equipment applications!

- Silicone glass materials where tough Class "H" heat-resistant products of high dielectric strength are required . . .
- Sturdy, resilient bias-woven tapes where tight bonding over irregular surfaces and contours is necessary . . .
- New Epoxy resin-treated tapes to eliminate wrapping voids, provide a high dielectric strength in the Class "B" temperature range . . .
- Pressure-sensitive silicone glass tapes, where good bonding to metal or itself is required in the Class "H" range . . .
- A host of cambric, paper, asbestos, canvas, glass and combination materials — more than 60 in all — to meet a wide variety of insulating requirements . . .
- And a complete line of quality varnishes and resins meeting rigorous U. S. Navy specifications . . .

In all, there are over 100 different Westinghouse insulating materials that have been *field proven* for your special requirements. Many provide unique design and performance advantages — smaller motors, for example, can do heavier jobs when they are insulated to operate safely at high temperatures. High solvent resistance, abrasion resistance, and amazing elongation and regain without loss of dielectric strength are other qualities built into particular products in the Westinghouse line.

Why not call your nearest Westinghouse office today or fill in the coupon below for complete information. J-06640

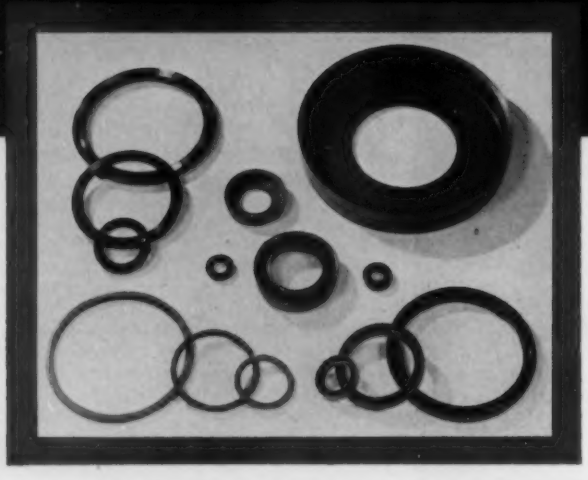
PE-4-57

Westinghouse Electric Corporation
MICARTA Division, Trafford, Pa.
Plase send me your *Leadership Line Catalog* on Westinghouse insulation, tapes, resins and varnishes.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

YOU CAN BE SURE...IF IT'S
Westinghouse

HOUGHTON . . .
Headquarters for Hydraulics



ONE SOURCE for
to get the full potential

Choose hydraulic packings and fluids that work together —

Select them from *one proven source;* then you know they will be compatible; no divided responsibility. And they will give new life to the systems you design.

Packings should do more for you than just seal pressure. In fact, unless the packings you choose are as modern and well-engineered as the system itself, you're going to be short-changed on wear and performance.

Fluids, too, ought to do more than just transmit energy. Today's fluids should be able to satisfy any demands you make on them, ranging from fire-safety to their chemical and physical ability to hold up over long periods.

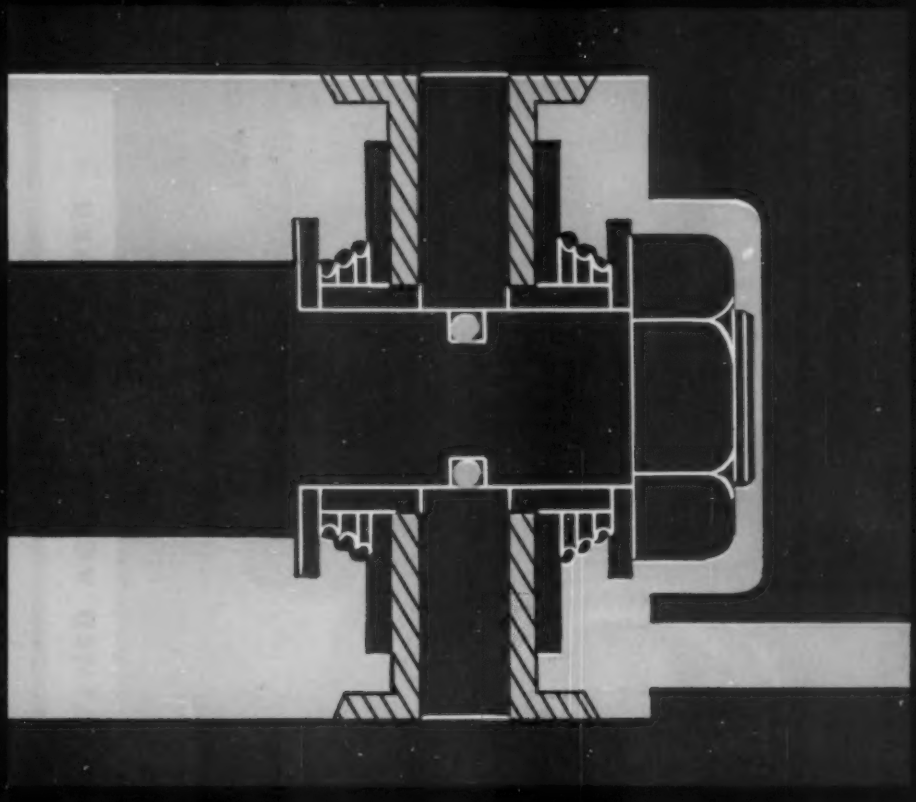
These Houghton packings and fluids illustrate the kind of "Extras" you need to give you *full* performance from every system you design:

1243-3 Rubber-Impregnated Leather Cups. Resilient as rubber, but with leather's tough wear-power and anti-extrusion qualities. These packings have opened new fields for designers.

VIX-SYN Fabricated Synthetic Rubber Packings. These new packings are setting records for wear. In tests, cup packings have withstood as many as 28,000 wearing cycles at 4,000 psi without signs of failure.

VIX-SYN Homogeneous Synthetic Rubber . . . "U"-cups, "V"s and "O" rings . . . you'll find the same kind of advanced thinking reflected in the many special compounds available for varying service conditions and fluids.

Houghto-Safe 620. A non-petroleum, aqueous base hydraulic fluid which provides maximum fire resistance. In addition to complete fire safety, it helps packings give superior service because it is chemically inert to all standard packing materials. Its



Spring Loaded
Cup Packings . . .
A HOUGHTON "First"

Packings and Fluids
of your design . . .

lubricity and film strength prolong pump and equipment life. Use it in over 80 percent of all hydraulic applications.

Houghto-Safe 1020. Where systems demand higher lubricating qualities along with fire-resistance, this new Houghton fortified phosphate ester type fluid is your best bet.

Hydro-Drive. In systems where petroleum fluids are safe, Hydro-Drive offers all the advantages of pure, high-quality oil plus chemically-increased film strength, lengthened service life, and fortified gum-dissolving, rust-preventing power.

Hydrolubric. As an additive for water-operated hydraulic systems, Hydrolubric very nearly makes oil out of water. It prevents rust, keeps evaporation to a minimum, and delivers positive, reliable lubrication to all working parts.

You get another assist from Houghton in packing engineering. Square shoulder cups and the wear-saving spring mount for cup packings are Houghton developments. Standard stack heights for "V" Packings is another innovation that lets you use any one of three kinds of packings in the same gland.

Write — or make sure to ask the Houghton Man when he calls at your plant — for full information on all the new Houghton developments for Hydraulic and Pneumatic equipment.

. . . products of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

Lightweight! But magnesium can really take punishment

Magnesium is the world's lightest structural metal. It weighs only 23% as much as steel, 20% as much as yellow brass and 65% as much as aluminum. But magnesium is strong, too. How strong? Look at a few of its uses in the aircraft industry, for example:

The magnesium wheel in the picture above has to be light, but it also has to withstand tremendous shock when the plane touches down. In another application, the entire weight of a two-ton helicopter is suspended from a magnesium rotor. In large cargo planes magnesium floor members support heavy weights in flight.

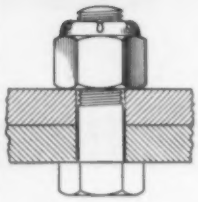
Magnesium was selected because it has the necessary lightness, strength, rigidity, durability and other desirable properties. It's the *combination* of light weight and strength that makes magnesium the choice for countless applications throughout industry.

What do these facts mean in terms of your products, parts or equipment? They mean that magnesium can do an equal or better structural job at a substantial savings in weight. For more information, contact the nearest Dow sales office or write to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Department MA 1401H.

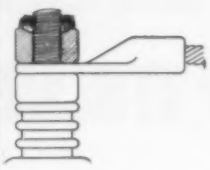
YOU CAN DEPEND ON DOW

Ten fastening problems solved by ELASTIC STOP® nuts

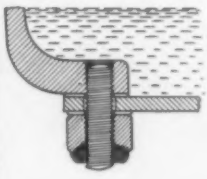
TIGHTENED AGAINST THE WORK



Vibration and impact proof bolted connections in standard applications.

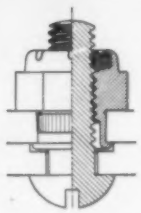


On all electrical terminals subjected to vibration in transit or operation, and for any electrical or electronic assembly where positive contact must be maintained.

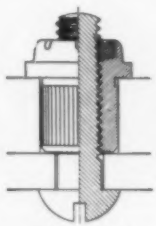


To seal bolt threads where leakage past stud threads must be prevented.

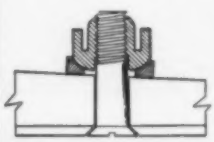
FOR MANY SPECIAL FUNCTIONS



Blind fastening applications where nut is "clinched" into sheet metal . . . becoming self-retaining as well as self-locking.

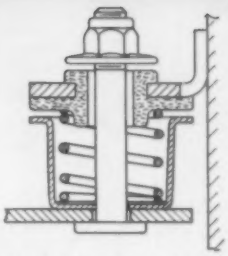


To eliminate drilling and tapping and provide steel thread strength for soft metals, an ESNA spline nut is pressed into a bored hole in casting.

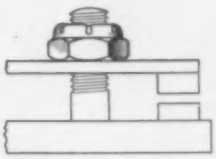


Simplified self-aligning self-locking fastener for bolting two non-parallel surfaces.

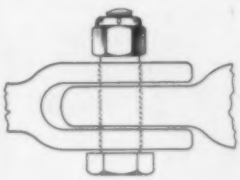
LOCKED ANYWHERE ON THE BOLT



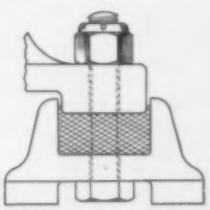
Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted. (Flanged face eliminates need for extra washers.)



On make and break adjustment studs where accurate contact gaps must be maintained. Note "thin" height design for limited clearance.



For bolted connections requiring predetermined play.



For rubber-insulated and cushion mountings where the nut must not work up or down.

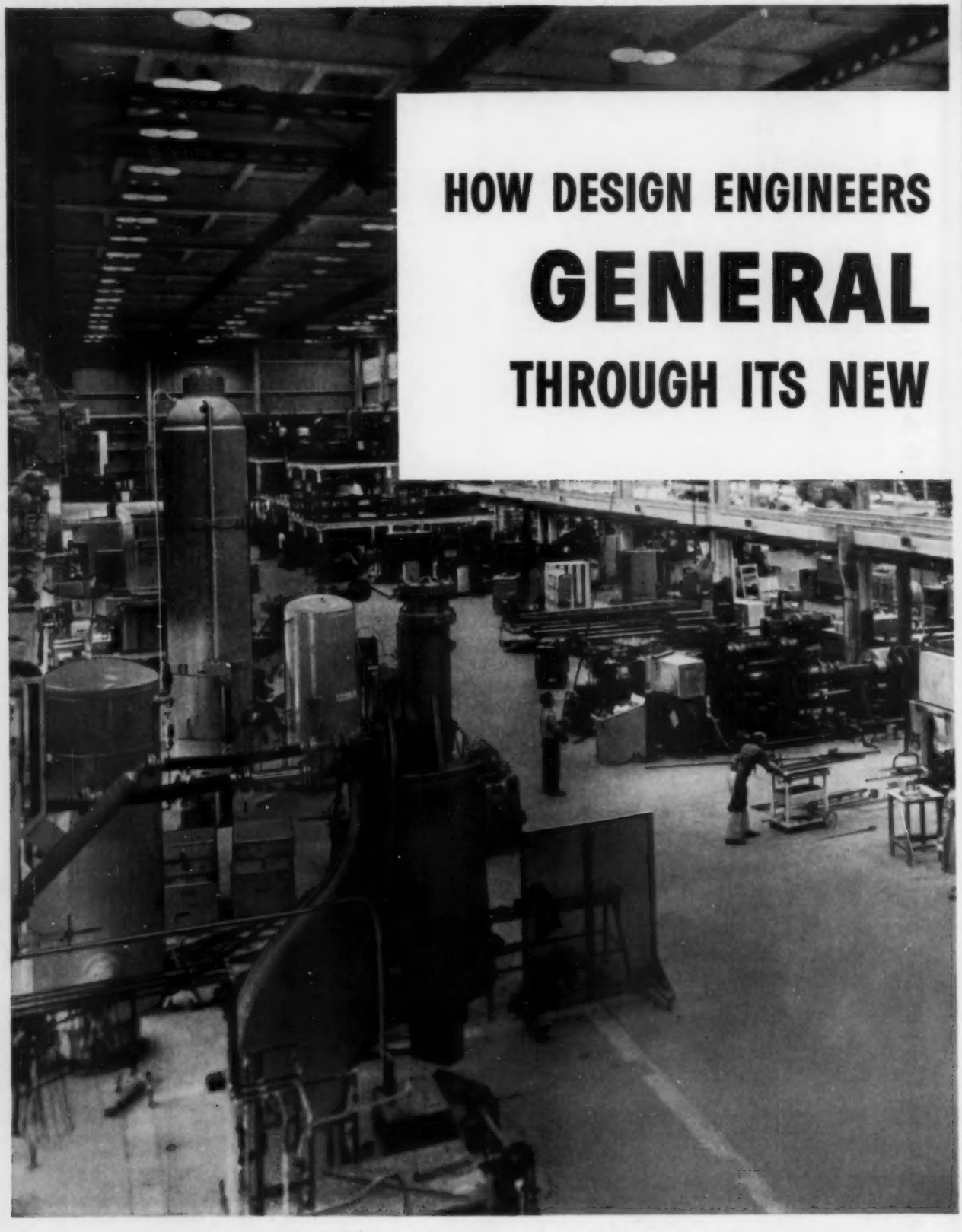
HOW THESE NUTS SOLVE SO MANY FASTENING PROBLEMS, ELIMINATING EXTRA PARTS AND OPERATIONS...

The red locking collar of an ELASTIC STOP® nut grips bolt threads with a perfect fit that will not loosen under severe vibration or stress reversals, and seals against liquid seepage. By bringing nut and bolt metal thread flanks into firm contact it eliminates wear producing axial play. The elastic locking action of the insert-type stop nut does not distort or gall bolt threads. It is reusable many times.

Send for the following free information: Elastic Stop nut bulletin; Rollpin® bulletin. Or enclose a drawing of your product for specific self-locking fastener recommendations. Write to Dept. N30-42.

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA
2330 VAUXHALL ROAD, UNION, NEW JERSEY.



HOW DESIGN ENGINEERS GENERAL THROUGH ITS NEW

Laboratory with factory-size equipment – that's the new $5,000,000 G-E metals and ceramics laboratory in Schenectady. From here will come many of the products manufactured by the Metallurgical Products Department of General Electric Company, 11127 E. 8 Mile Street, Detroit 32, Michigan.

BENEFIT FROM THE RESOURCES OF

ELECTRIC

METALLURGICAL PRODUCTS DEPARTMENT

Solutions to your most pressing problems — plus developments ahead of industry trends — are now being worked out in our laboratories

Because designers needed a metal harder and more wear-resistant than steel, General Electric brought out Carboloy® cemented carbides. Because designers needed a more powerful magnetic material, General Electric developed improved types of Alnico permanent magnets. Because designers needed better high-temperature metals, General Electric created new vacuum-melted alloys.

These, and many other vital products for design engineers, are the result of General Electric's tremendous resources of technological know-how and skilled manpower in the field of metallurgy. They are created in G-E laboratories . . . and produced for industry by the new Metallurgical Products Department.

This Department is the successor to the Carboloy Department, which was originally organized to manufacture carbides. It now produces such widely divergent metallurgical products as hevimet, thermistors, and Thyrite® varistors . . . in addition to chrome and tungsten carbides, and permanent magnets.

The very range of its products indicates how the resources of General Electric are being put to work solving the design engineer's most pressing problems through modern metallurgy.

Perhaps more important, G-E resources like the new Research Laboratory in Schenectady, and the manufacturing facilities of the Metallurgical Products Department, are now combining their talents to produce *ahead* of the trends and needs of industry.

In the Metalworking Industry, for example, this combination of G-E resources has already made one such contribution: Carboloy Cemented Oxide — a new kind of cutting tool material with so great a potential for super high-speed machining, that new machine tools must be designed to take advantage of all it offers.

Developments like these are essential to industrial progress . . . and they are typical of the parade of products design engineers can expect from the G-E Metallurgical Products Department.

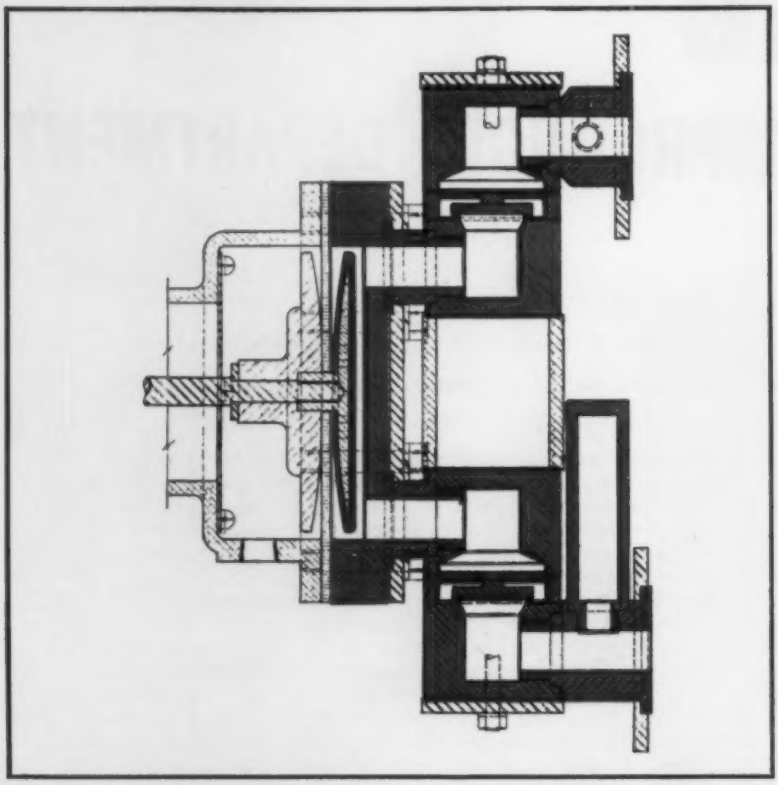
Progress Is Our Most Important Product

GENERAL ELECTRIC

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

PRODUCT
LATEST PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS

New diaphragm pump features structural and anti-corrosive properties of TEFLON®



No other material but TEFLON tetrafluoroethylene resin comes in contact with the pumped liquid in this diaphragm pump. Unaffected even by hot corrosives, components of TEFLON provide a hermetically sealed passage for the flow of chemicals and is rated for use from −50° to +300°F. (Manufactured by O. K. Machine and Tool, Inc., Waco, Texas.)

Extensive structural use is made of Du Pont TEFLON resins in the new positive displacement pump pictured here. Sturdy components of solid TEFLON are assembled to form the hermetically sealed pump head. The pump has no packing glands or rotary seals to leak irritating or obnoxious fumes. Parts of TEFLON can be machined to accuracies of half a mil.

The operating diaphragm in the pump is faced with TEFLON. Thin sheets of TEFLON exhibit tremendous toughness and flexibility. The covering of TEFLON easily withstands the vibrational load of the pump shaft operating at a pump rpm of 350. This type of construction eliminates churning of the pumped liquid, since the linear motion of the diaphragm is only 9 feet per minute.

The pump will successfully handle chemicals such as alkaline solutions, all acids of full or medium concentration, and petroleum hydrocarbons. It is rated for operation from −50°F. to +300°F. TEFLON itself can be used at temperatures to 500°F. and does not become brittle even at temperatures as low as that of liquid helium. For more information on the properties and uses of TEFLON, check the coupon.

CONTROL PANELS for colorful, new washers and dryers are molded of crystal-clear DuPont LUCITE®. LUCITE acrylic resin has about one-third the weight of glass and good impact strength. Chemically resistant LUCITE is unaffected by soap or detergent solutions . . . smooth, glossy surface is easy to clean. (Appliances are manufactured by Home Laundry Department, General Electric Company, Louisville, Kentucky.)

BEARING for auto generator (on left) uses thin side pieces of ZYTEL nylon resin stamped from strip as grease seal. Bearing tired with black ZYTEL is used as guide on passenger door of aircraft. Economical and durable, it needs no lubrication and damps rattles. (Made by Nice Ball Bearing Co., Philadelphia, Pa.; strip extruded by The Polymer Corporation of Pennsylvania, Reading, Pa.; tires molded by Strauss Engineering Co., Philadelphia, Pa.)

AUTO COMPASS utilizes durable globe of LUCITE® acrylic resin. The strong lens is composed of two hemispherical shells of LUCITE heat-welded together and filled with a clear liquid for damping the compass movement. LUCITE has outstanding optical properties. (Shells of LUCITE acrylic resin are molded by General Industries Company, Elyria, Ohio, for Hull Manufacturing Company, Warren, Ohio.)

ENGINEERING NEWS

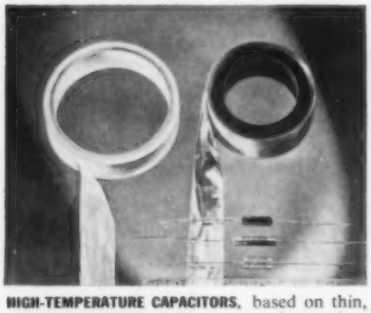
ZYTEL®, TEFLON®, LUCITE®

Du Pont TEFLON® resins can be bonded with commercial adhesives

A new, special technique has been developed to alter the surface of TEFLON tetrafluoroethylene resins so that commercial adhesives will bond to it. For designers, maintenance and production engineers, this opens up new ways to take advantage of the remarkable properties of TEFLON. Large surface areas can now readily be covered with TEFLON. Tanks, vats, pipes and digesters can be lined with this extremely inert engineering plastic to achieve exceptional chemical resistance at working temperatures as high as 500°F.

Good bonding strength can be attained between treated TEFLON and wood, glass, steel, aluminum, copper, ceramics, plastics – and, in fact, any material that will bond with an adhesive. Pressure-sensitive adhesives can be used. In cementable tape and sheet form, TEFLON makes high-grade electrical insulation. Sticky materials release more freely from untreated surfaces of TEFLON than from any other material. It may be used as low-friction facings on hoppers and conveyor surfaces.

Details of this development and its applications are obtainable on request. Use the coupon.



HIGH-TEMPERATURE CAPACITORS, based on thin, cast films of Du Pont TEFLON tetrafluoroethylene resin, pack maximum charge in minimum volume. Shown are films of TEFLON ¼ mil thick, with and without vacuum-deposited layer of aluminum. TEFLON has outstanding dielectric and thermal properties . . . present design permits capacitor operating range of −94°F. to +392°F. (Capacitors by Balco Research Laboratories, Inc., Newark, New Jersey; films by Dilectrix Corporation, Farmingdale, Long Island, New York.)

Abrasion-resistant ZYTEL® nylon resin replaces metal for pump impeller

"Dolphin" submersible pump has spiral-vaned impeller made of tough ZYTEL nylon resin. One of the seven stages of the impeller is displayed on the table. ZYTEL outwears steel in this application and is approximately 5 times lighter. The pump can easily be handled by one person. (Pump by Tait Manufacturing Company, Dayton, Ohio. Patent pending.)

Du Pont ZYTEL offers many opportunities for unique and reliable designs, as shown by the "Dolphin" pump impeller. ZYTEL is resistant to shock, abrasion and mechanical stress. The tough, hard surface of ZYTEL is unharmed even when the pump operates in a medium laden with grit and sand.

Because of the light weight of Du Pont ZYTEL (sp. gr. 1.14), problems of inertia are reduced. The motor is subject to less strain during starting and stopping. Weight is greatly decreased, and the center of gravity of the pump is displaced toward the base.

Parts of ZYTEL operate under water without corroding. ZYTEL is unaffected by most common chemicals, including oil and grease, alkalis, dilute mineral acids and most organic acids. It is rated for use at 250°F.

Intricate pieces are readily molded from ZYTEL. In this case, use of ZYTEL eliminated the need for expensive casting and machining. ZYTEL is easily injection-molded to precise dimensions and may be used with no further finishing.

Du Pont ZYTEL is available in several formulations for convenient application to design needs. The coupon will bring you detailed information.

SEND FOR INFORMATION

For additional property and application data on LUCITE® acrylic resin, TEFLON® tetrafluoroethylene resins and ZYTEL® nylon resin, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept. Room 135, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *ZYTEL;* ☐ *TEFLON;* ☐ *LUCITE. I am interested in evaluating these materials for:*

NAME_____ POSITION_____

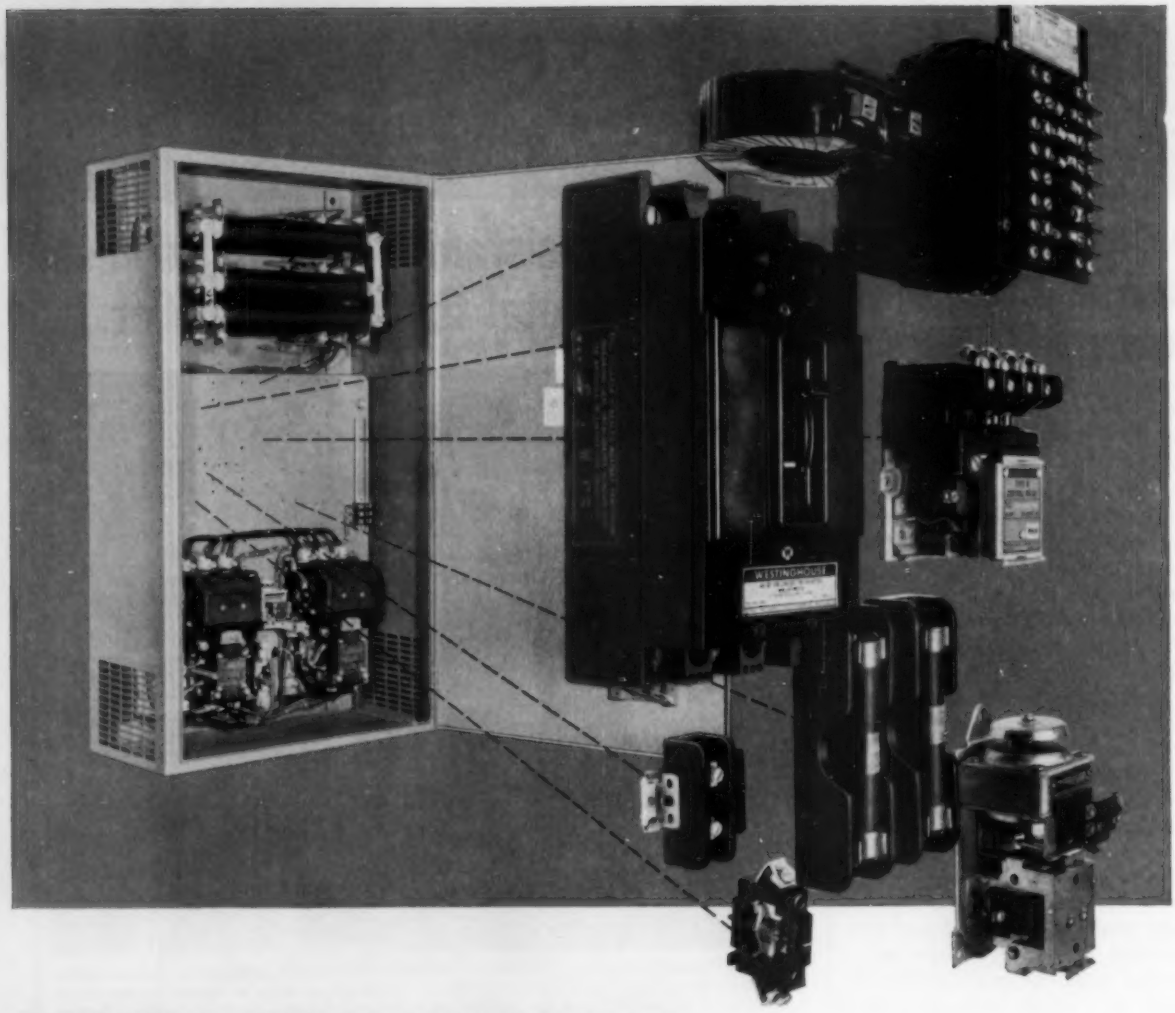
COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.



REDUCED VOLTAGE STARTER

. . . built to grow with Add-A-Part Panel

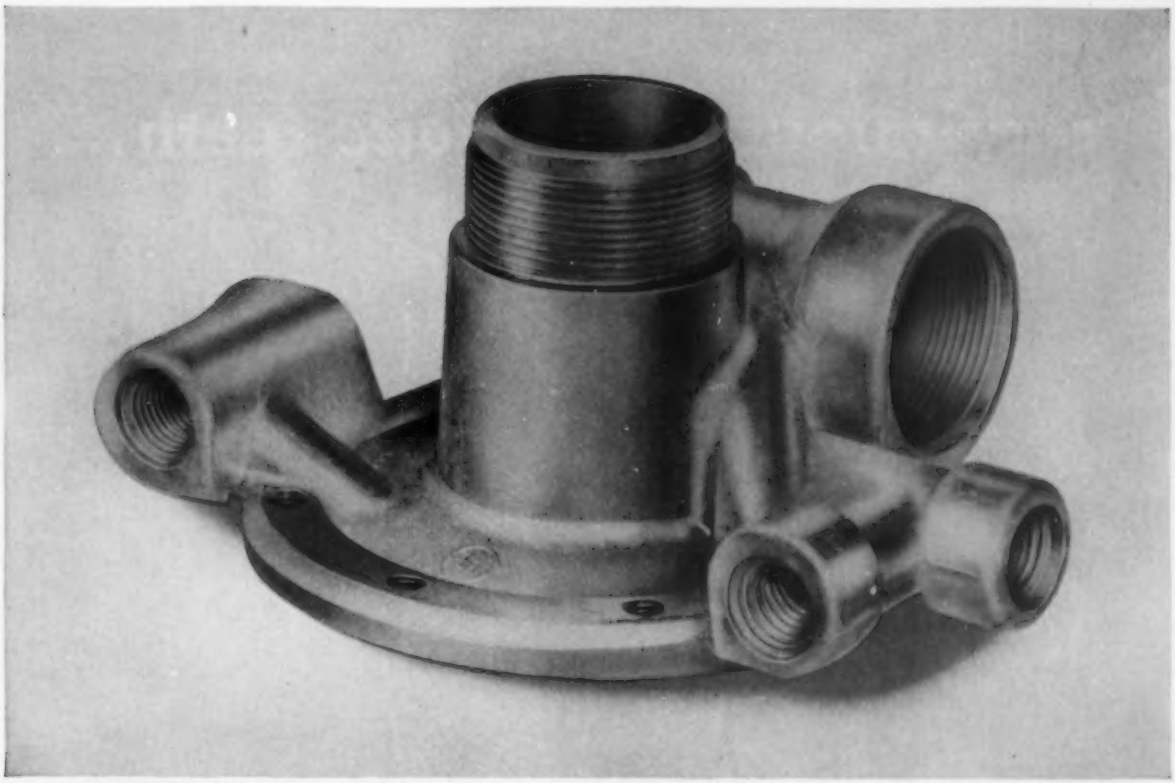
Room to grow is built right in at the factory with the Westinghouse Add-A-Part panel. When additions to systems require such modifications as control circuit fuses, auxiliary relays, or current transformers, the space for them is there—engineered right into industry's most advanced reduced-voltage starter.

Other features that make this starter the most flexible, available today include pneumatic types AM and AMB relays for easy, stepless timing adjustment—adjustable resistor taps so you can adjust starting voltages to meet your requirements.

For all the facts, call your Westinghouse sales engineer. Ask for DB 11-500. You'll see one more reason why you can be sure . . . if it's Westinghouse. J-22022

YOU CAN BE SURE...IF IT'S

Westinghouse

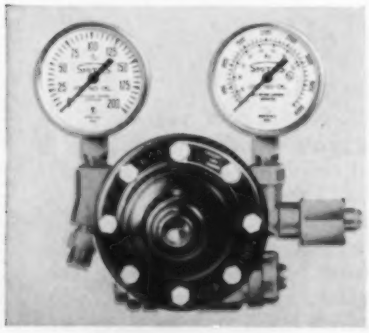


Anaconda Die Pressed Brass Forging after machining, ready for assembly in the gas-pressure regulator shown below.

Better regulators at less cost—with die pressed forgings

Save 25% in first cost—cut machining time, tool cost

Smith Welding Equipment Corp. of Minneapolis uses Anaconda Die Pressed Brass Forgings for gas-pressure regulator bodies as a result of the following analysis of the job.



Smith's two-stage oxygen regulator, Model H313. One of the Smith Welding Equipment Corp. products using Anaconda Die Pressed Brass Forgings.

First, die pressed forgings make a superior product because the twice-wrought metal has the uniformity, denseness, toughness, and strength to prevent gas leaks and to withstand pressures that run in excess of 2500 psi. And second, the forgings do the job economically. The initial cost of the die pressed forging is 25 percent less than the cost of sand castings. In addition, savings are realized in substantially reduced tool costs and machining time. And finally, the forgings are finished in a simple bright-dipping operation, with savings over sand castings estimated at 5 cents a unit.

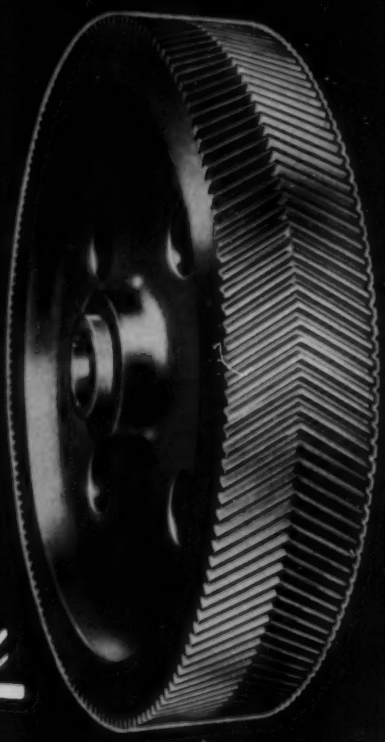
SHORT CUTS: Anaconda Die Pressed Forgings are short cuts to superior products. Because of their high strength, hardness and resistance to impact, abrasion, and corrosion, they serve better functionally, often replacing more costly built-up assemblies of cast, stamped, drawn, or other machined parts. Their consistent accuracy of dimension eliminates most surface machining to size, permits trouble-free use of drilling jigs, threading or milling fixtures, broaching vises in secondary operations. They are ideally suited to high-speed automatic chucking machines.

The die pressed forging technique is practically unlimited in diversity of shape and field of application. Specialists at The American Brass Company will be glad to submit estimates on the cost of forgings for your critical components. Just submit a sketch or sample of the part involved—or write for Publication B-9. Address: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario. 5706

ANACONDA® **COPPER ALLOY DIE PRESSED FORGINGS**

Short cuts to superior products

continuous *Backbone* teeth...



give *you*

these advantages...

Added strength, plus increased load-carrying capacity in smaller space result from the famous "backbone" construction of these gears (formed where the helices meet), where the full face width of each gear tooth is put to work. Because the continuous teeth of all Phillie Gear herringbones are accurately generated on the most modern machines, these gears assure smooth, continuous and highly efficient gear operation . . . year-in and year-out.

If you have a problem involving high horsepower speed reduction under heavy shock loads, specify Phillie Gear Continuous Tooth Herringbones, and be assured of quiet, vibration-free, long-lived transmission of power, for both speed reducing and speed increasing applications.

Learn more about these outstanding gears by requesting Catalog # G-655.

phillie gear®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Virginia Gear & Machine Corp. • Lynchburg, Va.

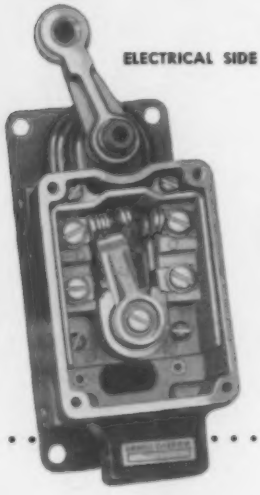
PROVED . . . by millions of contacts

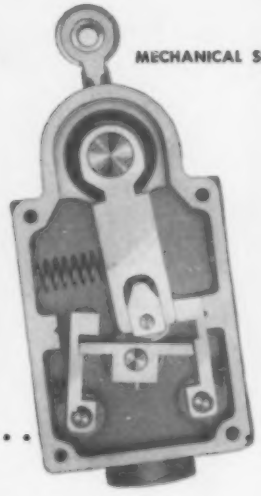
NATIONAL ACME
SNAP-LOCK
TRADE MARK

As illustrated below, National Acme SNAP-LOCK Limit Switches employ a basically simple yet positive *snap-action* locking mechanism—with extremely few moving parts. Thus wear is reduced to a minimum and dependable trouble-free service, far beyond normal limits, is assured.

The double-throw contact lever, connected directly by shaft with the latch bar, carries self-wiping coin silver contact points to assure quick action make or break—reducing wear ever further.

Electrical and mechanical sides are separated by a wall within a sturdy die-cast housing which is fully insulated and is dust and oil-tight.





THE ORIGINAL
SNAP-ACTION LOCKING SWITCH

SNAP-LOCK LIMIT SWITCHES. Made in single-pole and double-pole series, in four types: Standard, Short Travel, Neutral Position and Push Lever. With the exception of the Push Lever Switch, all are adaptable to special enclosures for hazardous location service and may be used with various styles of operating levers. For AC or DC service.

and now . . .

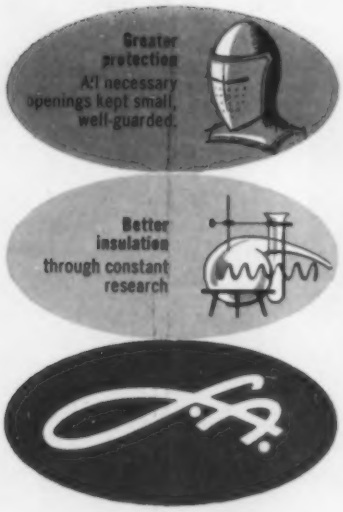
a new design concept for **CONTROL STATION SWITCHES**
the heavy-duty . . . oil, water, dust tight **GOLD-N-RING**
made by machine tool builders to machine tool specifications

Heavy duty silver-alloy contact points provide maximum electrical capacity, long life.
Heavy duty terminal screws have ⅜" thread contact to prevent stripping during installation and permanently secure wires for continuous, trouble-free service.
Single or double-pole contact block assemblies—can be used interchangeably with several types of GOLD-N-RING push button and selector operator heads.
Rated for 600 volts—AC or DC. Meets all Joint Industry Committee and National Machine Tool Builder's Association requirements.
Protected against oil and water seepage in operator head by Sealtight oil-resistant rubber diaphragm.
Easily replaces existing switches.

ELECTRICAL MANUFACTURING DIVISION

the National Acme company

170 EAST 131st STREET, CLEVELAND 8, OHIO



Be glad you weren't working here...

But this sturdy Louis Allis motor was, and still is!

Shortly before this picture was taken, that pulp-mill pump suddenly ruptured. Blasted every object in the area with a thick coating of hot paper pulp.

But note the Louis Allis 20 HP splash-proof motor designed to take this kind of abuse — and come back for more! Note that it took the full force of this blast on its vented *underside* — a motor's most vulnerable point. Only a sturdy, well-designed motor could resist this. Still functioning perfectly this one didn't miss a beat!

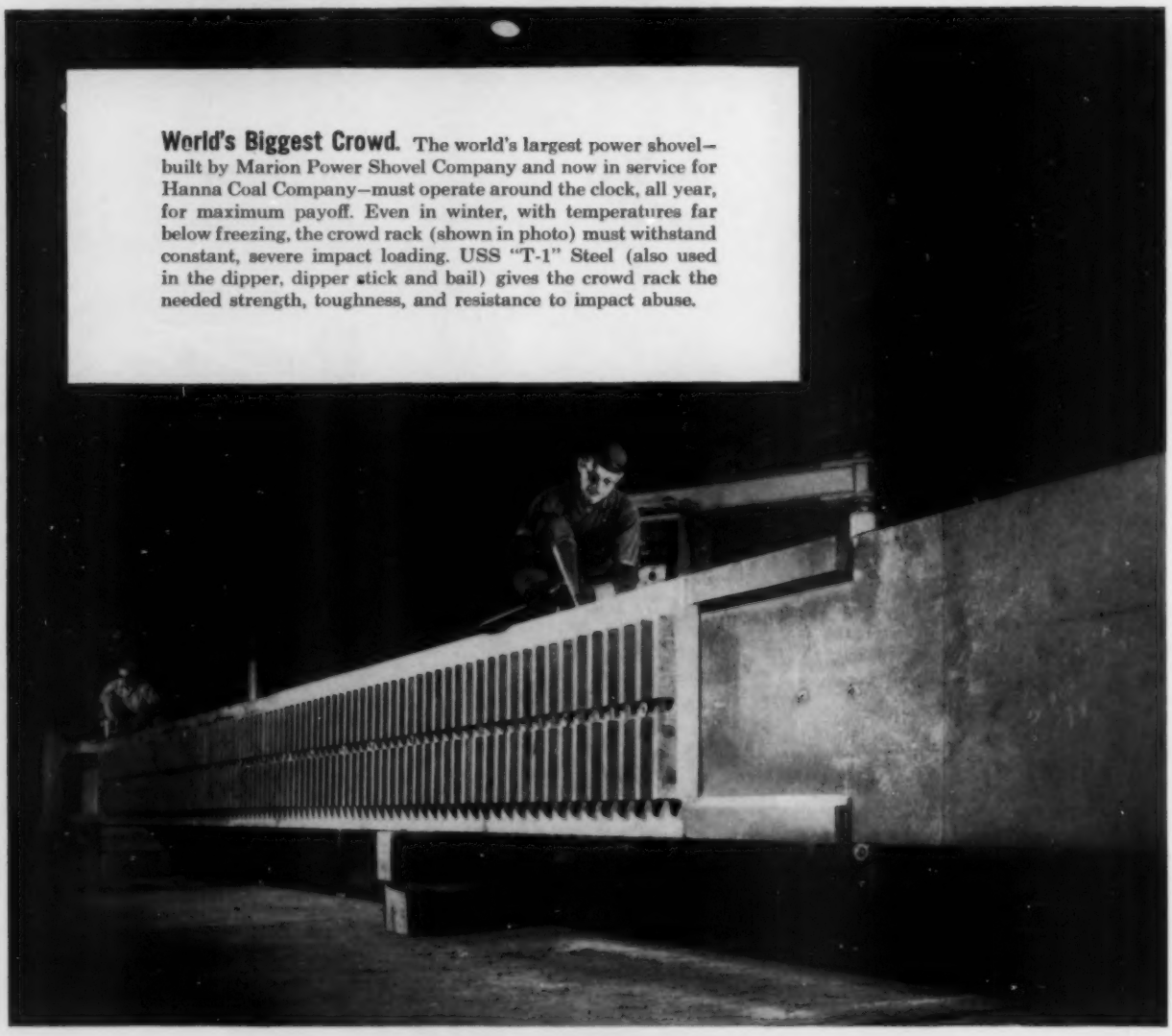
Let us tell you more about Louis Allis electric motors. About such unique features as the new varnish of Gilsonite combined with phenolics and alkyds that provides the highest degree of moisture, acid, and alkali resistance . . . locked bearings that reduce end play and extend bearing life . . . the dynamically balanced rotor. And about the many other Louis Allis extras better discussed at length in our file-sized Reference Bulletin 1700. Why not write for it today? The Louis Allis Co., 458 East Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

HOW USS "T-1" STEEL IMPROVES THESE

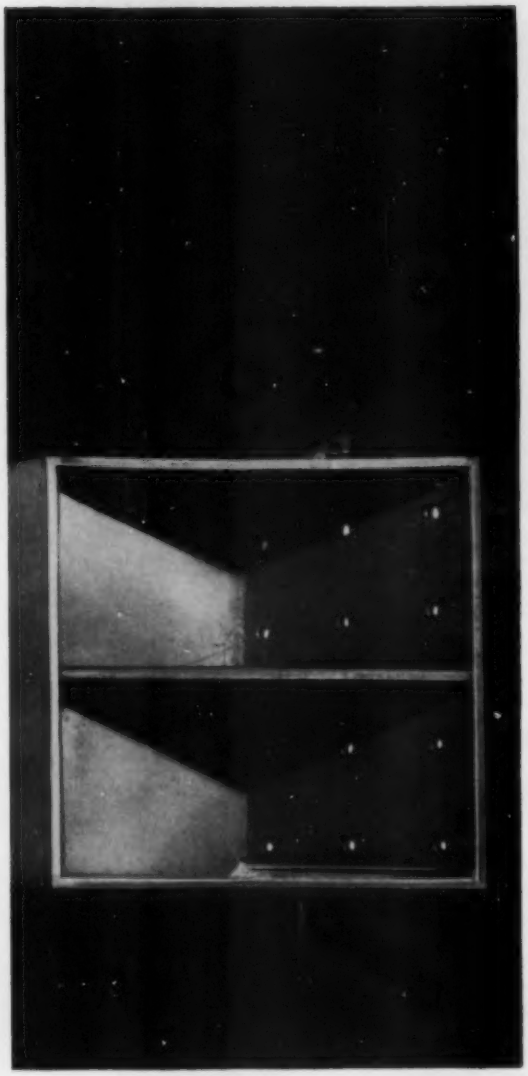
World's Biggest Crowd. The world's largest power shovel—built by Marion Power Shovel Company and now in service for Hanna Coal Company—must operate around the clock, all year, for maximum payoff. Even in winter, with temperatures far below freezing, the crowd rack (shown in photo) must withstand constant, severe impact loading. USS "T-1" Steel (also used in the dipper, dipper stick and bail) gives the crowd rack the needed strength, toughness, and resistance to impact abuse.



Unlined Bin. Here are the "makings" of an *unlined* coal storage bin being made by Fairmount Machinery Company, Fairmount, West Virginia. The very high strength of USS "T-1" Steel reduced weight and made the bin simpler to build because it cut down the number of stiffening members needed. USS "T-1" Steel will be welded in the field to cut fabricating costs. Good resistance to abrasion and corrosion of USS "T-1" Steel eliminated need for special lining inside the bin.

USS

PRODUCTS:



SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

Smallest Portable. This is the smallest 69 kv power transformer ever built by Maloney Electric Company, St. Louis, Missouri . . . occupies a space only 7' 11" x 14' 8", overall. Over a ton of weight was saved in the tank, alone, by using USS "T-1" Steel. The very high yield strength of this steel reduced the necessary thickness of the steel from ⅜" to ¼". The "T-1" Steel shell was fabricated by Nooter Corporation, St. Louis. The transformer—rated at 9,000 kva—was designed for Oklahoma Gas & Electric Corporation.

HOW MUCH DO THEY WEIGH?

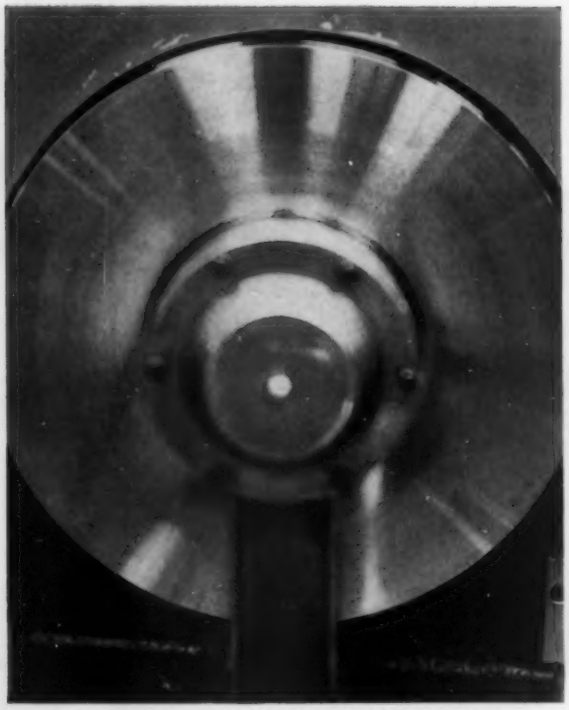
It's a contest. With prizes. The occasion: The Design Engineering Show in May. The reason: To get you in to see the "T-1" Steel exhibit. Here's all you do: Visit the U. S. Steel Booth and guess the weight of the "T" and the "1" which will be on display there. The pieces were flame-cut from USS "T-1" Steel. Visit our exhibit and see just how versatile this steel is. You may win a prize!

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T1" are registered Trade Marks

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

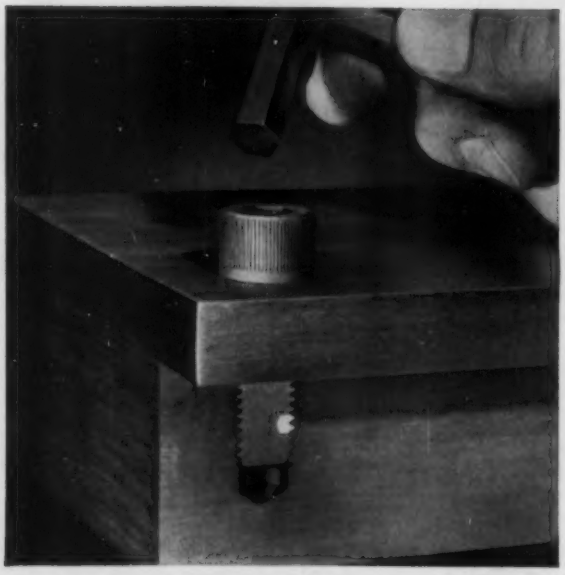
UNITED STATES STEEL



Self-locking UNBRAKO socket screws keep critical adjustments secure in the eccentric drive mechanism of this fatigue testing machine. Drive system delivers varying loads up to 15,000 pounds force to equipment under test at 1050 cycles per minute.

Vibration won't loosen Self-locking UNBRAKO socket cap screws

Screws with Nylok* device permit adjustments, keep precise settings during long test runs



HOW IT LOCKS. The tough, resilient Nylok locking pellet keys itself into the mating threads. It forces threads together, and locks the screw securely—whether or not the screw is seated.

UNBRAKO socket screws with the Nylok self-locking device stay tight under constant vibration.

Take the eccentric drive system in the fatigue testing machine illustrated above, for example. This machine must frequently run for periods up to 2 weeks or longer, day and night, to complete a single test. Loosening of the screws which are used to adjust the tension-setting mechanism could not only cause damage to the machine, but also make the test data worthless. Self-locking UNBRAKO socket head cap screws eliminate such problems.

An UNBRAKO socket screw with the Nylok self-locking device is a single unit. Just screw it into any tapped hole. Seated or not, it locks positively wherever wrenching stops. Constant vibration or pounding, or endless running of a machine, won't affect these self-locking UNBRAKOs. The screws will not work loose!

Write today for your copy of Form 2193, which gives complete catalog and technical data on the entire line of UNBRAKO socket screws with the Nylok self-locking device. Or see your authorized industrial distributor. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

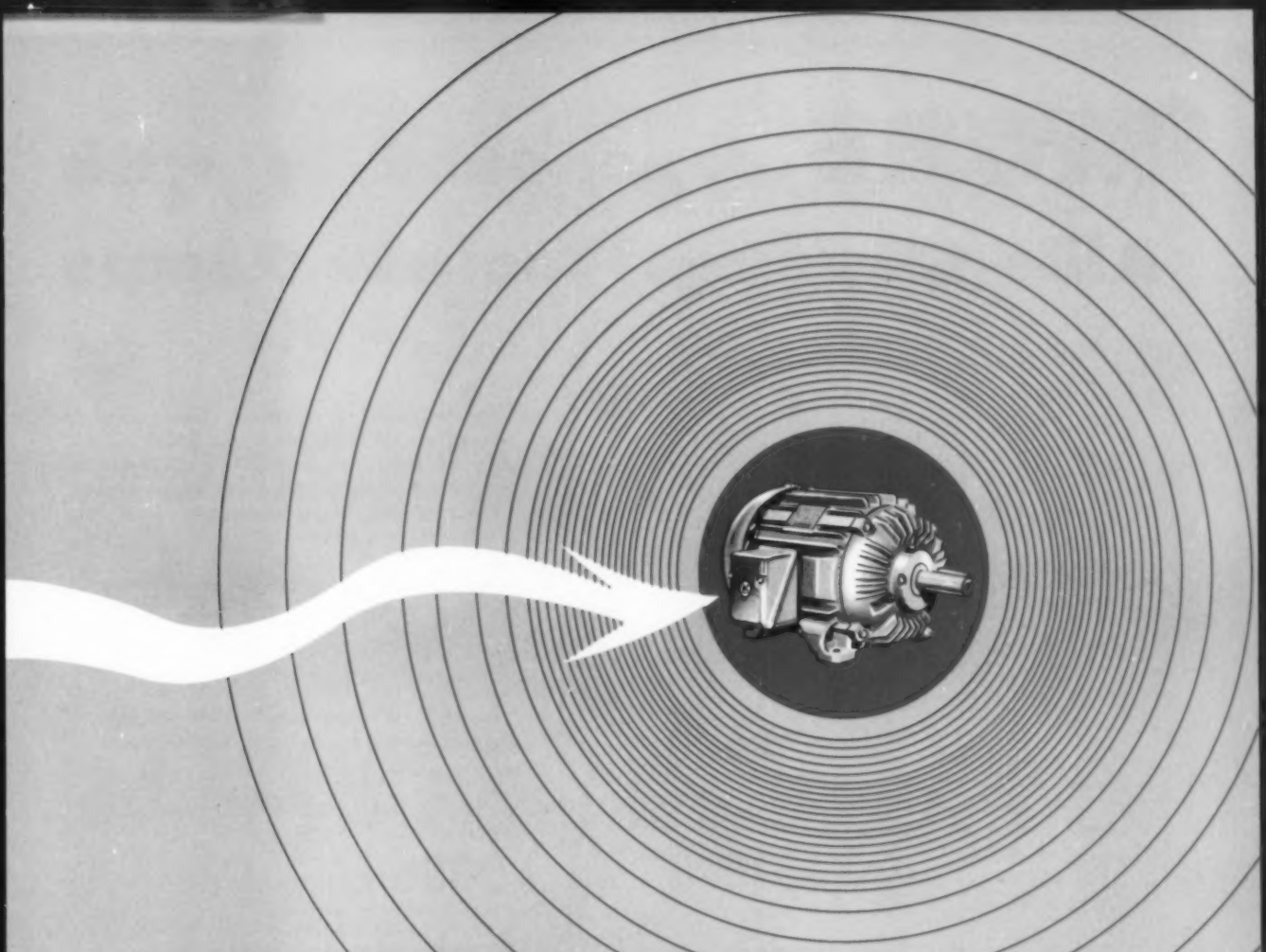
UNBRAKO® SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

*T.M. Reg. U.S. Pat. Off. The Nylok Corporation



The real cost of MOTORS

The cost of a motor extends over its entire lifetime. It does not end with purchase price. Cost *goes up* with every shutdown, every motor maintenance stoppage. Cost *stays down* when you buy quality. And quality means Allis-Chalmers.

All of these extras that don't show on the Allis-Chalmers nameplate — more copper, more iron, more cooling provisions—exemplify the quality-craftsmanship that goes in before the price tag goes on.

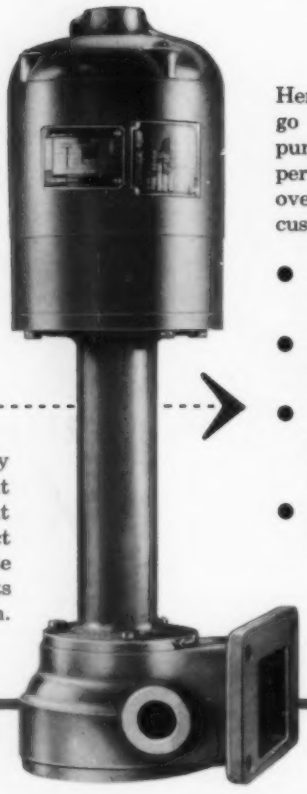
For the "long run," either as a new machinery component or as replacement, specify Allis-Chalmers. Find out more about *real* quality in motors from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5287

MORE dependability with Allis-Chalmers Coolant Pumps



Here's a complete line of coolant pumps made to go and go on the equipment you build. These pumps have been designed by Allis-Chalmers experts in viscous liquid pumping and will contribute, over the long run, to repeat business from your customers. **Here's why:**

- Sturdy cast iron casing encloses entire unit to assure continued accurate alignment.
- Single-shaft construction maintains maximum rigidity, providing ultimate in bearing life.
- A variety of sealing arrangements are available that need no maintenance nor adjustment once pump is installed.
- The bearings are sealed and operate for years without attention.

These features and many others make A-C pumps right for your application. Find out more from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

This Coolant Pump
model is sidewall mounted, is sealless and has open impeller.

Available
in fractional and integral hp sizes, above model is designed for mounting on vertical surface.

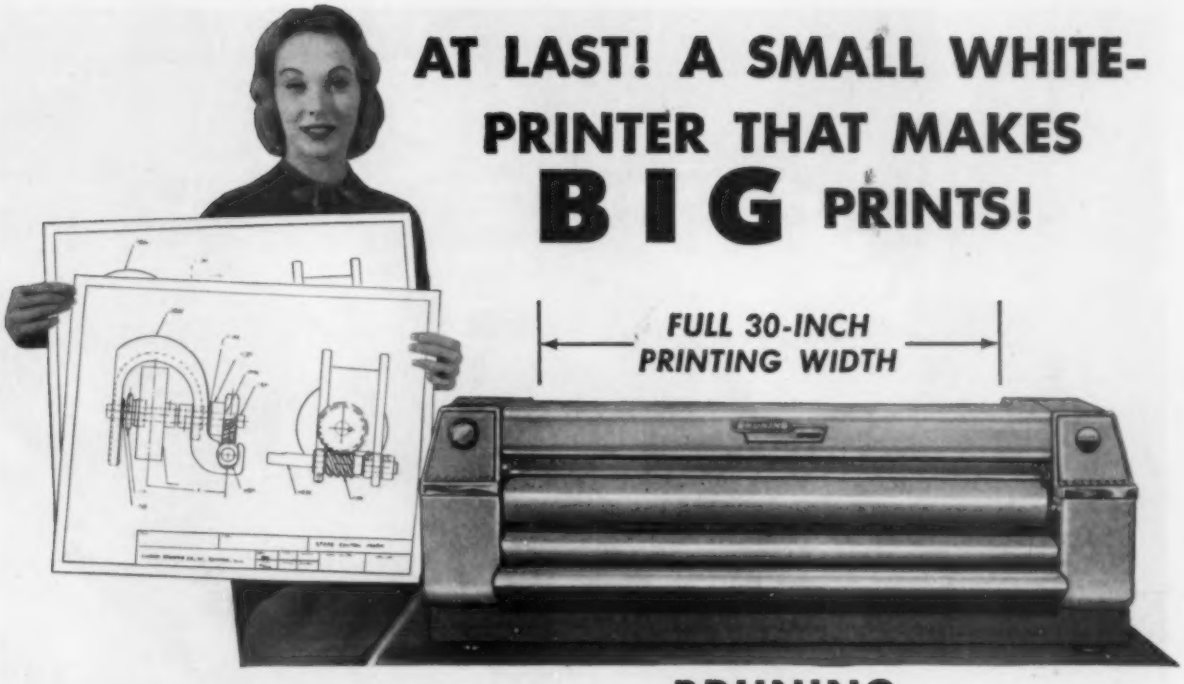
Vertically Mounted
on liquid reservoir, this design operates efficiently with varying liquid levels.

Submerged Mounted,
this type of pump is frequently used on machines requiring mounting in coolant tank.

Shallow Pump
or reservoir use is ideal for this submerged mounted model featuring a sealless design.

ALLIS-CHALMERS

A-5360



AT LAST! A SMALL WHITE-PRINTER THAT MAKES BIG PRINTS!

BRUNING

NEW! *Copyflex Model 300!*

Brings "Inside" Reproduction within the Means of the Smallest Engineering Firm or Department!
Now, with your low-cost, versatile Model 300, you can make high quality prints when you want them—rapidly, privately, and in any quantity. You can exercise complete control over valuable originals at all times.

Provides Large Companies an Economical Way to Supplement Main Reproduction Centers!
With its compact size, big printing width, and low cost, the Model 300 is an ideal helper for your big reproduction machine. Strategically located throughout your company, Model 300s can bring new speed, convenience, and efficiency to your reproduction operations.

Here it is! The compact, low-cost reproduction machine that offers all the versatility and big printing width of a large, expensive whiteprinter!

Just think—you can make sharp, black-on-white prints in seconds of a drawing or tracing up to 30 inches wide by any length. And anyone can operate the Model 300 after only brief instruction. One fingertip control turns the machine on or off, and regulates its speed. Exposure and development are automatically synchronized.

The new Copyflex Model 300 is ideal for drafting rooms and offices because it can operate anywhere without annoyance to personnel in the vicinity. It is clean, quiet, and odorless. No exhaust venting, plumbing, or accessory equipment required. It needs only a connection with a 115-volt AC outlet for operation.

If you're pressed by the boom in production for more and more engineering prints, the all-new Copyflex Model 300 is your answer! Its low initial cost combined with outstanding economy and convenience of operation and maintenance make it your soundest, low-cost investment of the year. Mail coupon today! You'll be glad you did!

BRUNING Copyflex

Best Process! Best Machines! Best Selection of Materials!

Offices in 37 Cities of the U.S. and Canada

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Please send me information on the all-new Copyflex Model 300.

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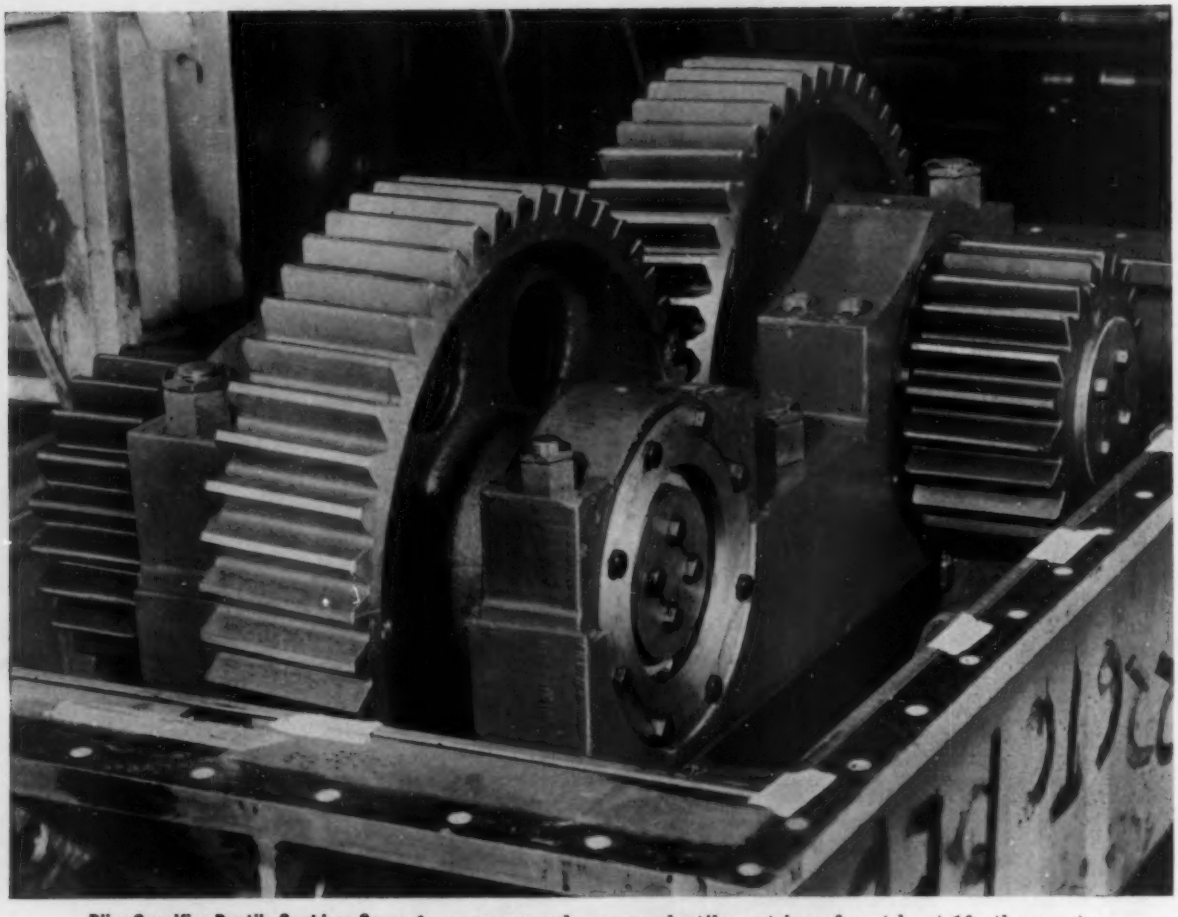


Bliss Specifies Ductile Cast Iron Gears for presses used to form sheet steel for the auto industry. Bliss uses ductile cast iron for at least 10 other parts in top drive presses – 16 in under drive presses.

Ductile cast iron gears prove their economy in Bliss metal-working presses

The gears, illustrated above, are typical of the many ductile cast iron gears used by E. W. Bliss Co. of Canton, Ohio, for their heavy metal-working presses.

For 30" to 108" gears, ductile iron has provided outstanding service. It gives Bliss the best combination of properties: high strength, good castability, good wear resistance and excellent machinability. All this at moderate cost.

In this gear application, 80-60-03 grade ductile provides a yield strength of 60,000 psi – more than enough to meet the stresses developed in producing 300- to 4000-ton platen loads.

These ductile iron gears – heat-treated to 208 Brinell – work well with the 8640 (Ni-Cr-Mo) pinions, assuring top-notch wear resistance. Bliss reports, *"not a single ductile iron gear replaced since ductile iron was first specified."*

Take advantage of the economy of ductile cast iron for your equipment. For many applications – cylinders, pressure vessels, pistons and the like – ductile iron outperforms conventional materials. Cuts production time. Behaves better in the shop. Saves time and money.

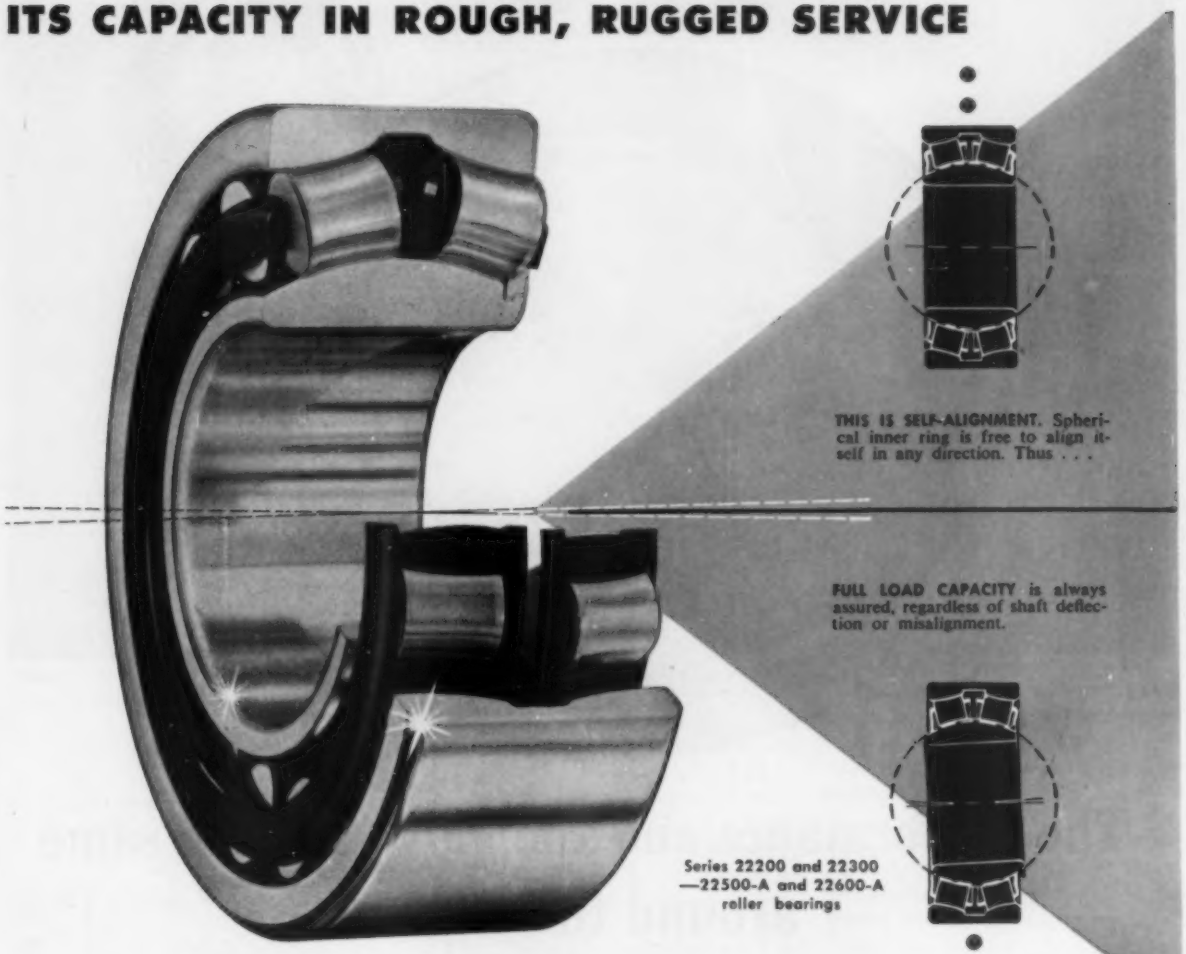
For complete information write for "Ductile Iron – the Cast Iron that Can Be Bent."

DUCTILE 1948

ductile iron . . . the cast iron that can be twisted and bent

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street, New York 5, N. Y.

Self-aligning TO KEEP ITS CAPACITY IN ROUGH, RUGGED SERVICE


THIS IS SELF-ALIGNMENT. Spherical inner ring is free to align itself in any direction. Thus . . .
FULL LOAD CAPACITY is always assured, regardless of shaft deflection or misalignment.
Series 22200 and 22300 —22500-A and 22600-A roller bearings

Spherical LINK-BELT roller bearing compensates for shaft deflection, weaving of supports

MANY leading makers of tough duty equipment now design without bulky supports to prevent deflections. They're using this spherical Link-Belt roller bearing that *compensates for misalignment* . . . always keeps its full capacity for handling radial and thrust shock loads without "pinching."

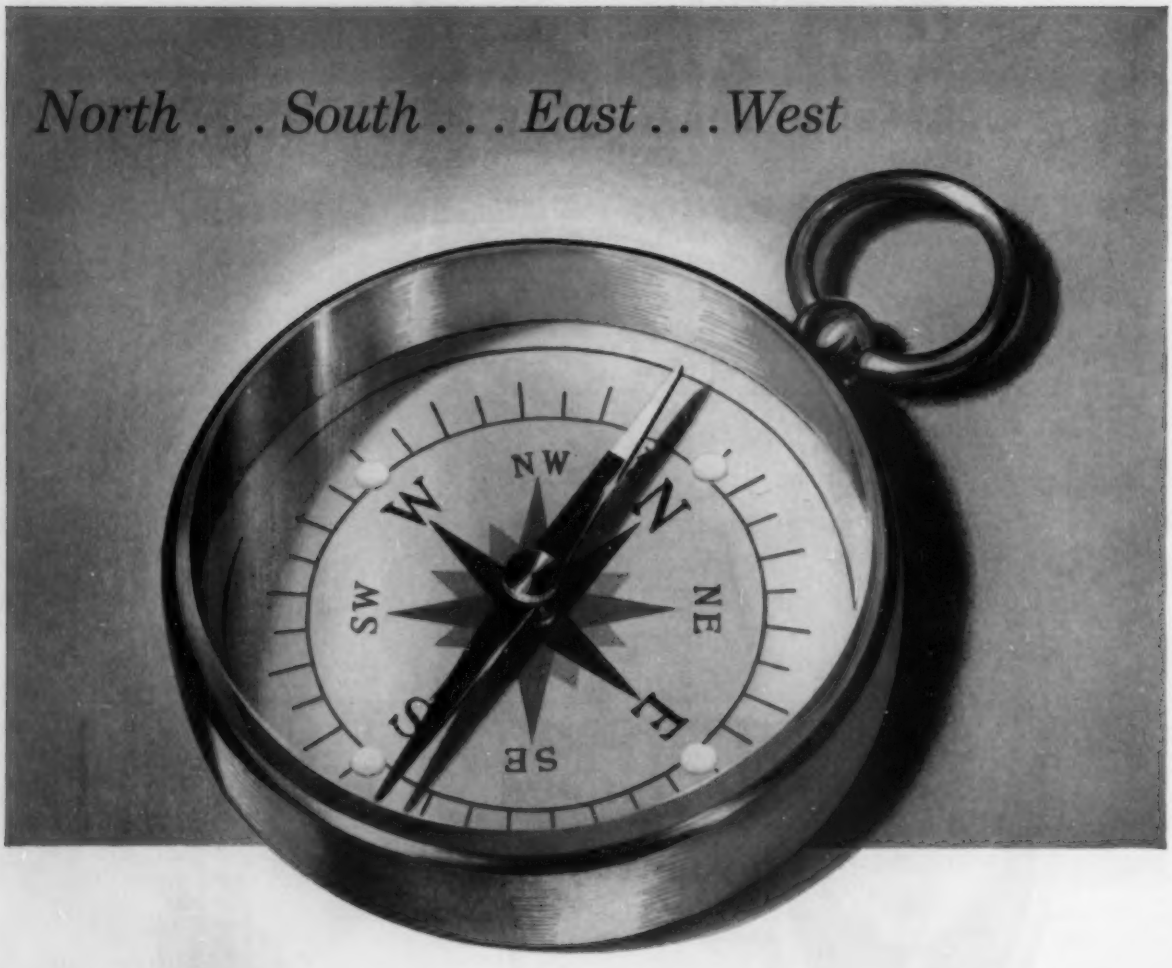
In addition, it's factory-adjusted, easy to mount and available everywhere with internationally standardized boundary dimensions.

Link-Belt also makes industry's most complete line of ball and roller bearing blocks. They're all in Book 2550—yours for the asking at any of 40 Link-Belt offices. 14.440

LINK-BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock-Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.



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SHELL INDUSTRIAL LUBRICANTS

Shell Alvania Grease, used world-wide as a multi-purpose lubricant, has an outstanding performance record in solving many of the toughest anti-friction bearing grease problems. Ideal for wet, humid applications (inhibited to prevent water corrosion), it lubricates under water-wet conditions which normally spell trouble.

Alvania* Grease has the added advantage of remaining plastic in sub-zero weather and stable under sustaining high temperatures. This one grease successfully replaces dozens of special lubricants in plant after plant . . . reason enough for its universal popularity. For complete information, write Shell Oil Company, 50 West 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.

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SHELL ALVANIA GREASE

A TRULY MULTI-PURPOSE LUBRICANT

SHELL

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DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 7

ALUMINUM FOR DUCTS

NEW RESEARCH DATA SHOWS ALUMINUM PROVIDES REDUCED HEAT AND FRICTION LOSSES

(THIS ADVERTISEMENT REPEATED IN RESPONSE TO THE HIGH INTEREST EXPRESSED BY ENGINEERS AND DESIGNERS.)

In No. 2 of these information sheets on Designing With Aluminum, which dealt with some of aluminum's thermal properties, mention was made that bare aluminum ducts were more efficient than bare galvanized or metal ducts covered with asbestos paper in delivering hot or cool air. This results from the fact that one of aluminum's useful properties is high reflectivity to radiant energy, and corresponding low emissivity.

Recent research studies by F. W. Hutchinson of Berkeley, Calif., have demonstrated that friction losses in aluminum ducts are substantially less than in galvanized ducts. This means that for the same duct size aluminum will require less power, and hence permit lower operating costs. Or, for the same friction loss, the aluminum duct will be of smaller diameter, thus providing for possible savings both in first cost and through more effective use of building space.

Duct Size Reduced By Using Aluminum

The new data have definite practical significance, as shown in Figure 1. This has been prepared for a heating system using bare aluminum duct with hot air in at 170°F and 100 feet of duct running through a space in which the ambient temperature is 60°F. It combines the influence of reduced friction loss and reduced heat transfer, and shows that substantial savings in duct size can be obtained through the use of aluminum.

The influence of heat loss (or gain in the case of air conditioning) is most important in small diameter ducts with low air velocities, while friction loss has the greatest significance in small ducts at high velocities. The result is that for small to moderate size ducts there is a saving in diameter of from 5% to 12% over the entire range of velocities.

Consider, in Figure 1, the use of a 6" duct with 700 feet per minute velocity: for these operating conditions the bare aluminum duct would be 12% smaller than an asbestos-paper covered galvanized duct. This means that the aluminum duct would handle a smaller volume of air to deliver equal heat at the point of discharge. Further, the velocity in the aluminum duct would exceed that in the other duct, but the loss in head would be the same.

Since the power requirements of an air distribution system depend on volume and head loss, it is evident that in this instance the bare aluminum duct would not only be 12% smaller, but would provide additional saving through lower operating power requirements.

In a series of actual tests it has been determined that the absolute roughness of aluminum duct is about one-third that of galvanized, on the order of 0.00015 to 0.0005. Friction charts developed directly for aluminum show, in comparison to friction charts for galvanized, a reduced friction loss which varies in amount with velocity and with duct diameter.

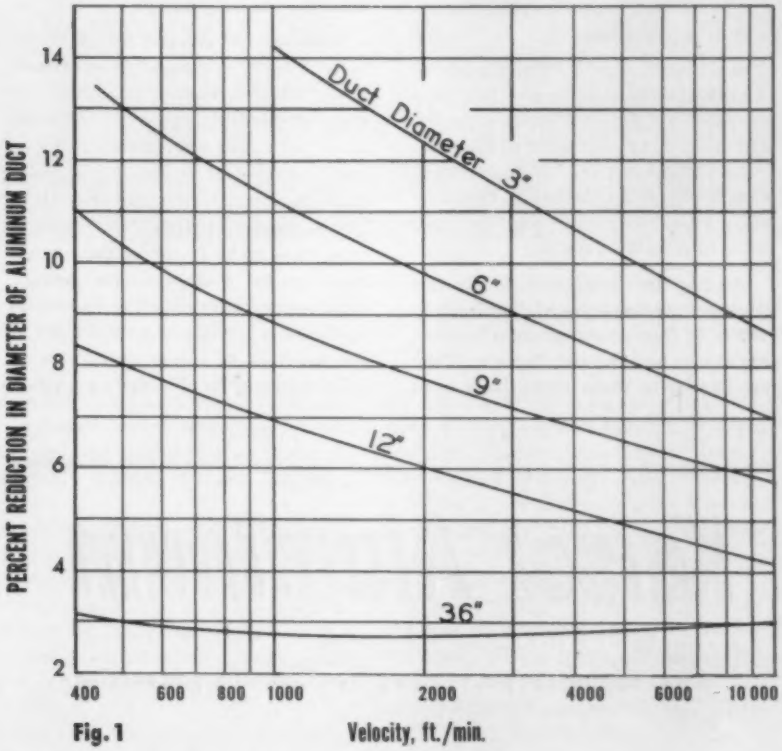

Fig. 1

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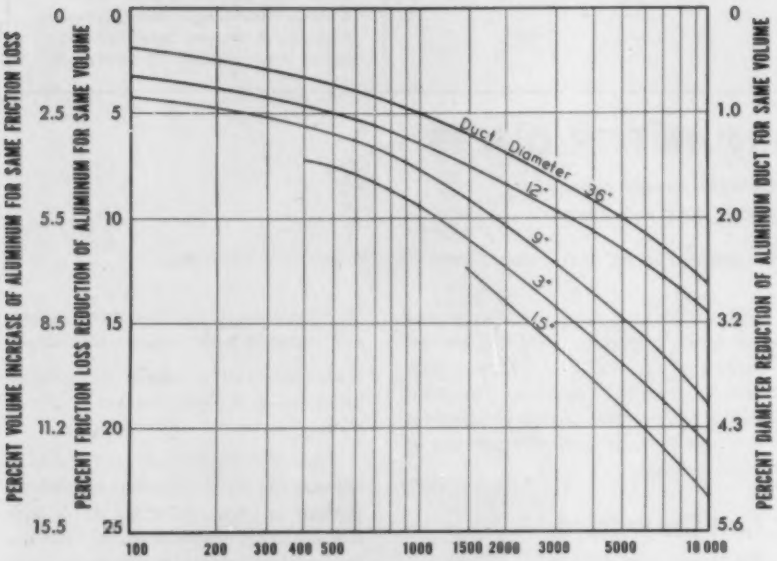


Fig. 2

Friction Most Important At High Velocities

For large ducts at low velocity the reduction in head loss is a few per cent, but small aluminum ducts at high velocity will afford savings in friction loss of 20% and over. This advantage of aluminum is of special significance in view of the increasing trend toward small high-velocity duct systems.

For systems used purely for ventilation or exhaust purposes, where the supply air is neither heated nor cooled, the reduction in size of aluminum duct, as compared with galvanized, is due entirely to the lesser friction loss. Figure 2 provides a means of comparing the two duct materials over a wide range of diameters and velocities, and permits the designer also to determine directly and exactly the comparative advantages of aluminum for any particular duct.

The scale at the far left in Figure 2 gives the per cent increase in volume which can be passed through an aluminum duct for fixed value of the friction loss; this volume increase would permit a corresponding reduction in diameter as given on the scale at the far right. In cases where it is not desirable to reduce the diameter, the aluminum duct would provide a reduction in friction loss as indicated on the inner scale at the left.

For example, a 9″ diameter aluminum duct carrying air at a velocity of 4000 feet per minute would have a friction loss approximately 13½% less than a corresponding galvanized duct. For the same friction loss the aluminum duct would carry approximately 7½% more air, and would be approximately 3% smaller.

A 32-page report, "The Design of Aluminum Duct Systems," has been prepared for Kaiser Aluminum by Mr. Hutchinson on the basis of the new data. It presents for the first time a design procedure, including graphical methods, directly and uniquely applicable to aluminum ducts.

Among the charts included in this book are charts giving friction loss per 100 ft. in aluminum ducts as a function of velocity, volume and diameter. They are similar to those which have been regularly used in connection with galvanized installations, but are developed especially for aluminum. Thus they enable the engineer to design directly for aluminum and avoid the necessity for the use of approximate conversion factors.

Copies may be obtained without cost by writing Kaiser Aluminum at 1924 Broadway, Oakland 12, Calif., or through any of the company's sales offices in principal cities of the country.

Additional Aluminum Advantages

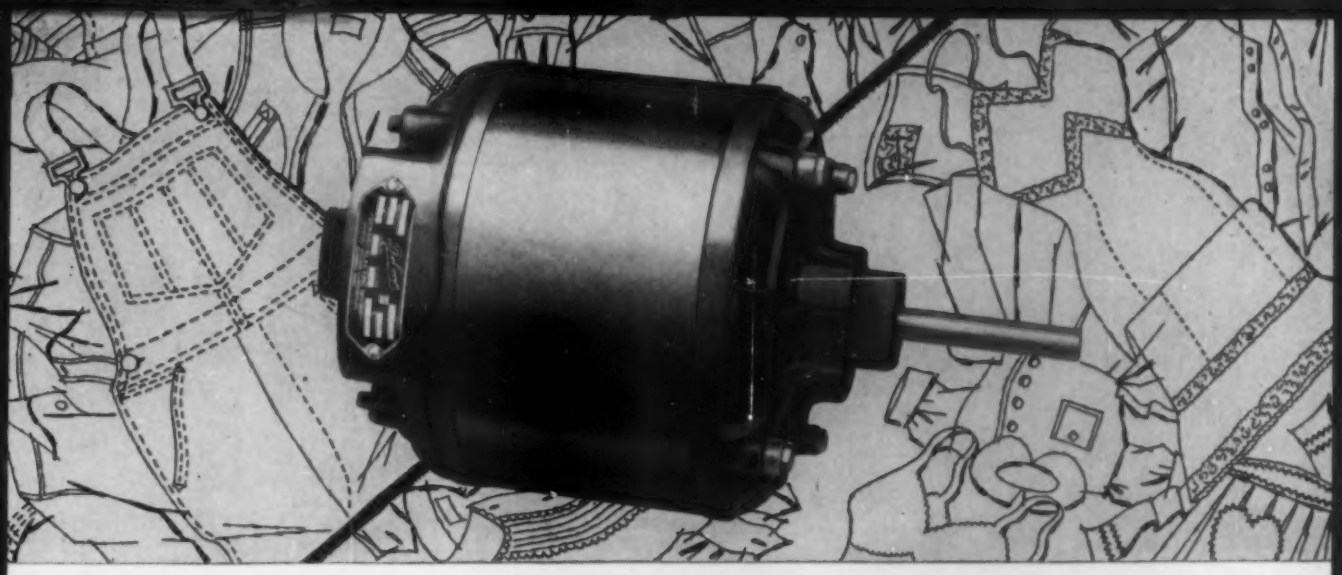
The lower heat and friction losses discussed above are not the only advantages to be derived from the use of aluminum duct work in heating, ventilating and air conditioning systems. Aluminum's corrosion resistance contributes to long life and minimum maintenance. Moisture does not cause red-rusting or stains. Its workability and light weight provide for reduced fabrication and installation costs. General practice calls for equal thickness of metal, whether aluminum or galvanized, in duct installations.

Although the advantages of aluminum in this type of application are naturally of most interest to heating and ventilating engineers, architects and those concerned with the construction and operation of buildings, they also provide an outstanding illustration of how aluminum's unique combination of properties make it one of the world's most useful and versatile metals. Assistance or information on individual application, fabrication procedures and the selection of alloys and forms of aluminum may be obtained on request.

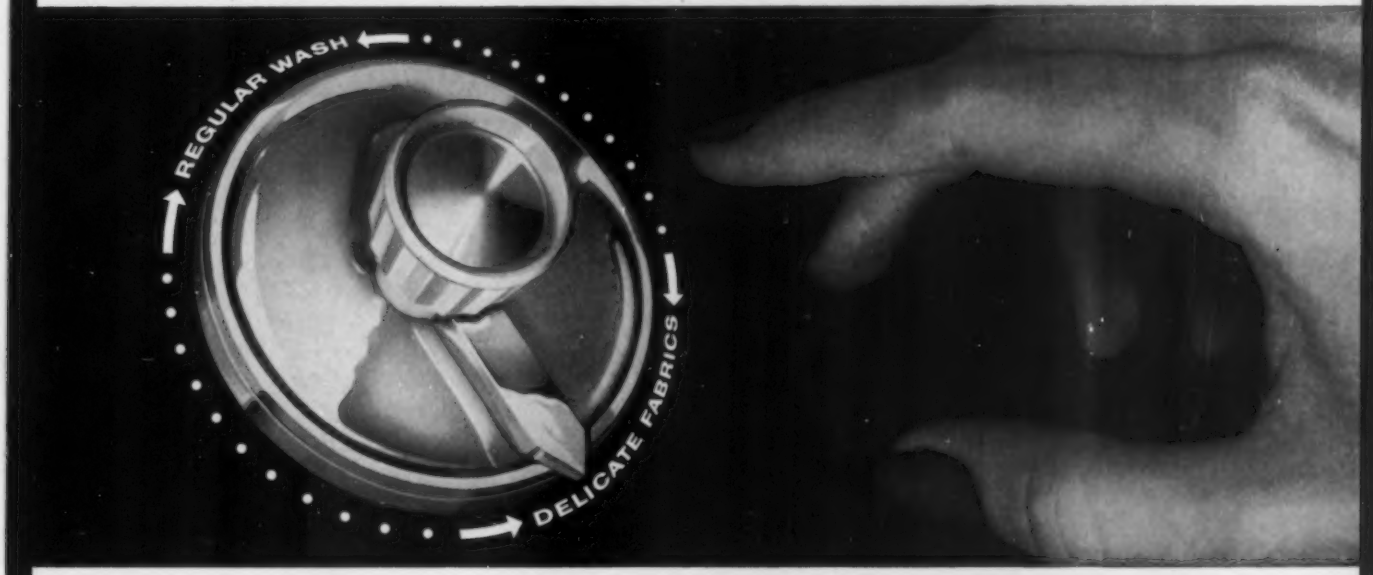
Kaiser Aluminum

see our catalog in PRODUCT DESIGN FILE or write for copy

Setting the pace . . . in growth, quality and service



PACKARD ELECTRIC / *NEW... custom-tailored washing machine motor*



FHP MOTORS / *Provides power for <u>two washing speeds</u>... electrically!*

It's an old idea based on need. Make the agitator speed variable. Then, both light and heavy clothes could be thoroughly washed without harming fabrics.

There were no two-speed appliance motors available with enough power at both speeds. Mechanical means, such as gears, belts and pulleys, clutches, etc., cost too much, took up too much space, made too much noise and caused too many maintenance problems.

A Packard Electric motor engineering team was first to solve the problem with a compact, two-speed unit that had just the amount of speed, power and torque required. And washing machine manufacturers who worked out the solution with Packard Electric engineers have had a big competitive advantage ever since.

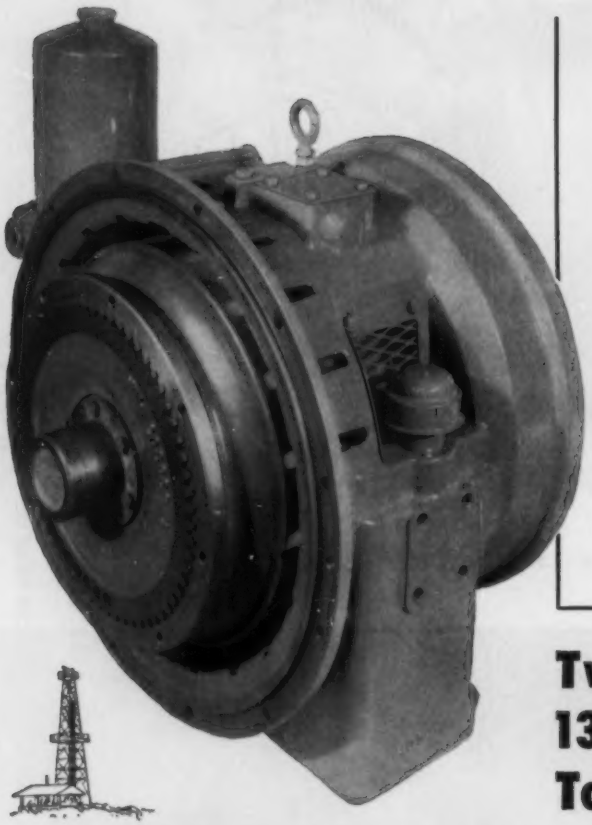
What's more, there are further savings in assembly when you buy Packard. That's because Packard will deliver a motor complete with special mountings and accessories to simplify your assembly procedures.

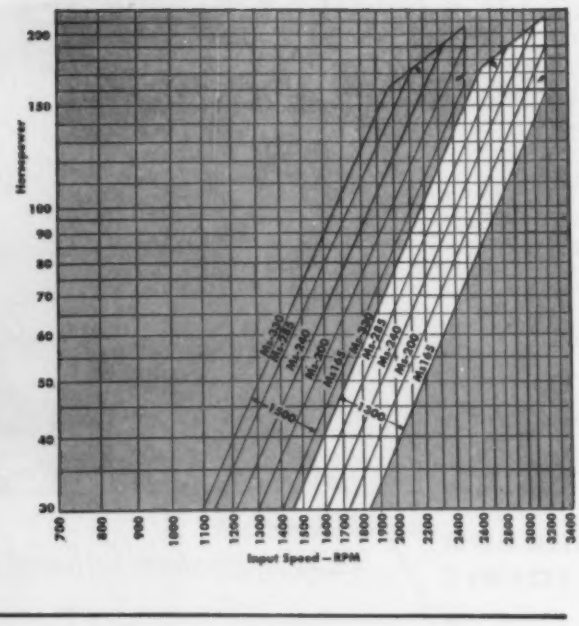
Packard Electric research and engineering teams have a long record of accomplishment in the custom-built motor field. And, even now, new ideas are on the boards to help our customers produce better, lower priced products for the appliances of tomorrow.

Packard Electric

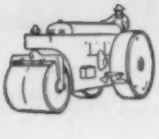
Warren, Ohio — GM GENERAL MOTORS

Division of General Motors





Twin Disc offers new 1300 Series Single-Stage Torque Converters



To meet the growing trend toward higher speed diesel and gasoline engines, Twin Disc Clutch Company announces its new 1300 Series Single-Stage Torque Converters . . . a series that offers ideal torque ratings for shovels, materials handling equipment, small industrial locomotives, front-end loaders, hoisting machinery, road rollers, graders and many similar applications.

The new 1300 Series Single-Stage Torque Converters are rated from 30 hp at 1450 rpm to 212 hp at 3200 rpm . . . with impellers available for specific torque ratings of 165, 200, 240, 285 and 330 pound-feet.

Current production of the 1300 Series consists of one model—the Model "F." This is a spacer-type arrangement with an SAE No. 2 flywheel housing size and either an SAE No. 2 or No. 3 output housing.

Like the Twin Disc 1500 Series Single-Stage units, the 1300 Series has an exclusive blade design which develops a counter-head at high-speed ratios, stopping fluid circulation. This simplifies design and construction and eliminates the need for a free-wheeled stator.

Impellers having different bladings (both number of blades and pitch) are interchangeable, permitting torque capacities to be matched more accurately to engines of various hp sizes and speeds.

The 1300 Series cooling requirements are minimized because of a rotating impeller housing which provides air circulation through the ventilated stationary housing.

If you've been considering a torque converter in your machinery designs, or are dissatisfied with your current single-stage units, investigate today the benefits offered by the new Twin Disc Single-Stage Torque Converters. Write for Bulletin 508 Supplement.

TWIN DISC

TWIN DISC
Torque Converters

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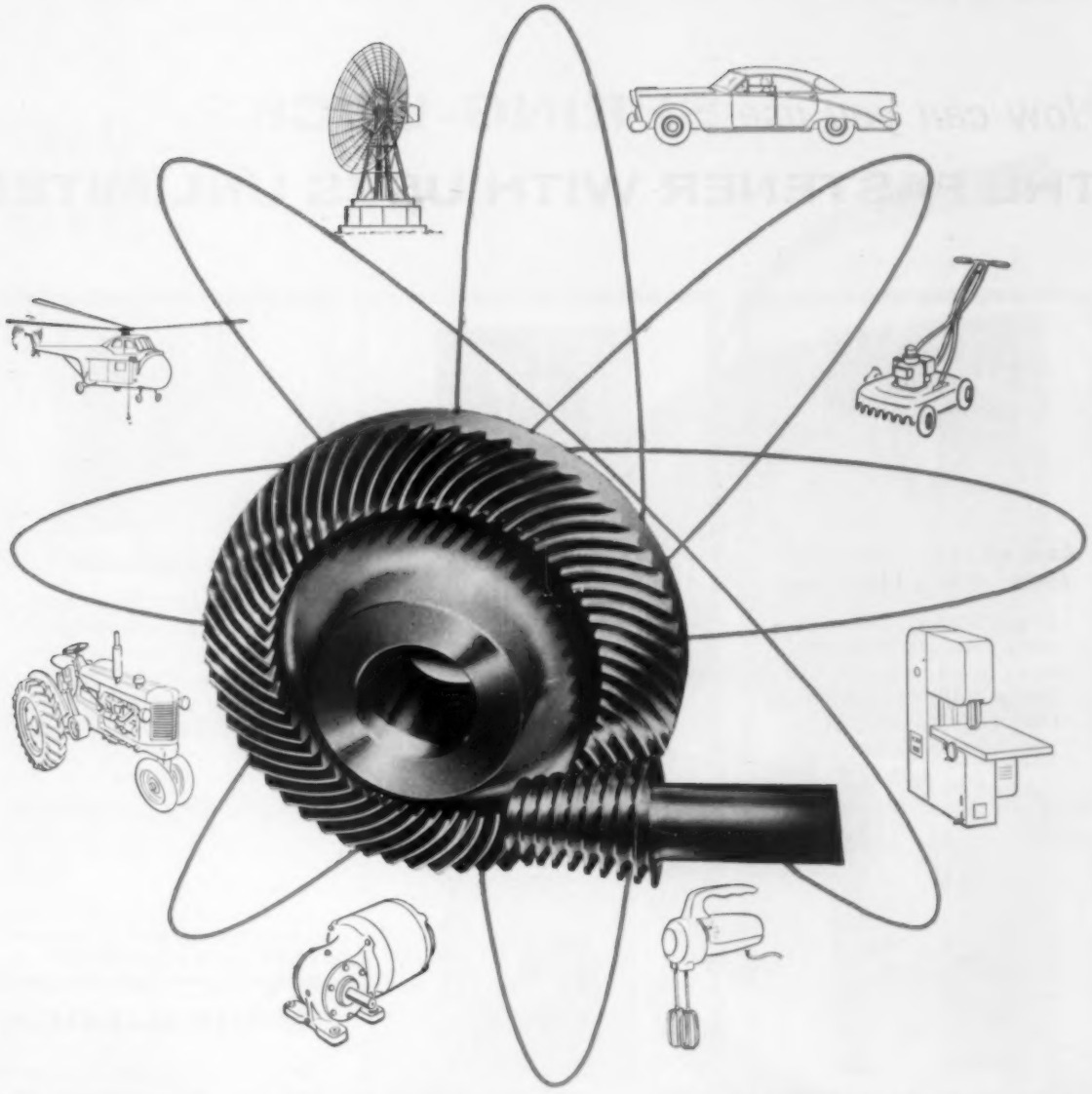

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for your product

SPIROID® GEARS SAVE SPACE—SAVE WEIGHT . . . OFFER POSITIVE BACKLASH CONTROL

Spiroid Gears extend the horizon of mechanical frontiers, offer new product design opportunities for increased performance standards. Comparatively smaller, stronger and more efficient, Spiroid Gears provide an entirely new relationship between power transmission and gear size. You get more power from less space, more profit from your product. Spiroid Gears can be produced in standard gear materials in any size and in ratios from 9:1 to 300:1. They are cut on conventional equipment, or can be molded, die-cast or sintered.

Write for informative Spiroid booklet, "More Power, Less Space."

Spiroid® Hobs for producing Spiroid Gears are available only from Illinois Tool Works.

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Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.

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Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.

As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

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To marketers, stainless steel combines the smart selling values of beauty and easy maintenance with the hard selling values of superior corrosion resistance, durability and toughness.

Stainless steel is available in countless work-saving standard shapes. It's readily machined, formed, joined, or cast.

For more facts about stainless steel and the contribution it can make to your product or marketing problems, see your stainless steel supplier or write ELECTROMET—leading producer of more than 100 alloys for the metal industries, including chromium and manganese used for making stainless steels.

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drive gears in BOLENS TRACTORS

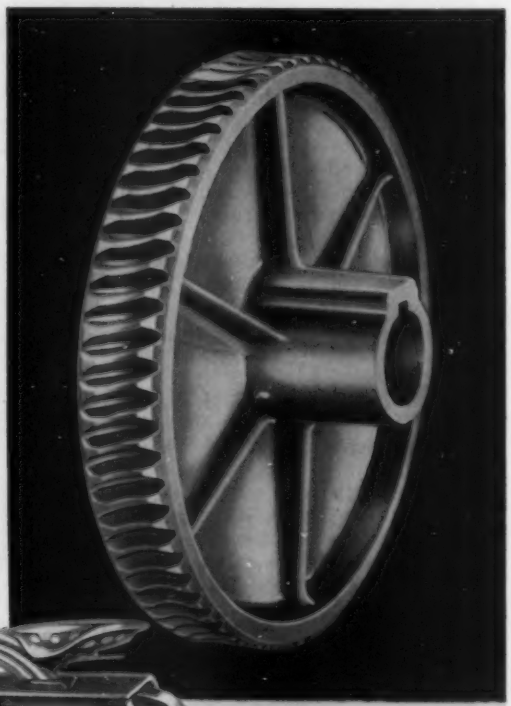
toughness of MUELLER BRASS

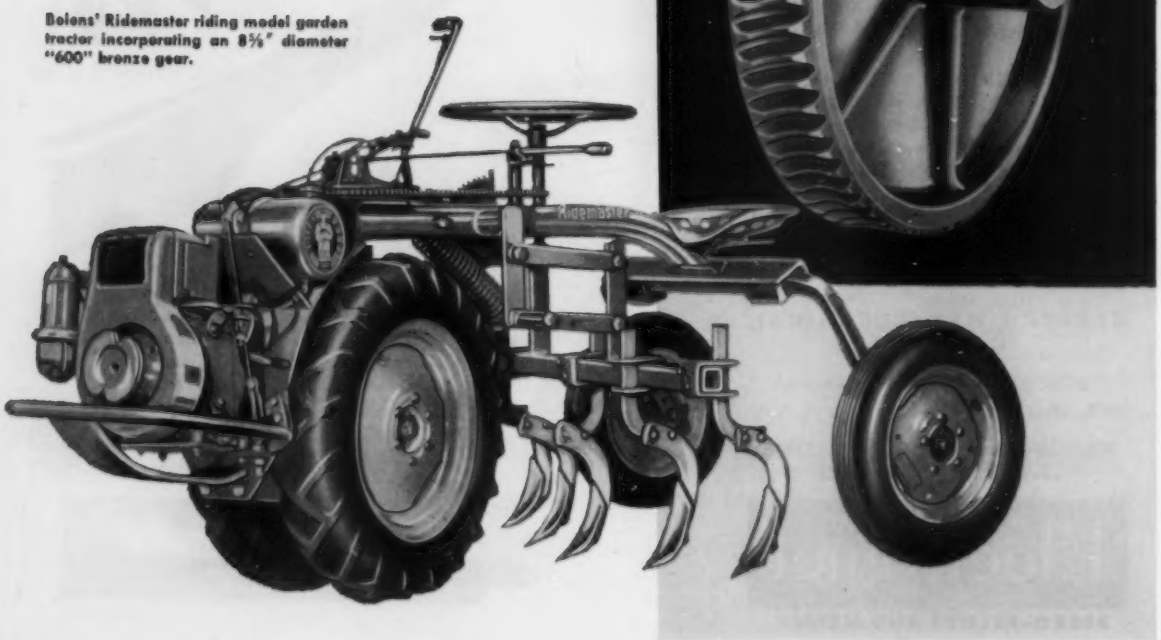
"600" series bronze alloys

Forged bronze gears made from tough, long-wearing Mueller Brass Co. "600" bearing alloy are proving their ability to withstand punishment in the popular outdoor power equipment manufactured by the Bolens Products Division of Food Machinery and Chemical Corporation, Port Washington, Wisconsin. The Junior and Super Mustang rotary tillers, all employ "600" main drive gears to dependably transmit engine power to drive assemblies. The going is rough for equipment of this type in cultivating or tilling heavy soil—but Bolens has a record for ruggedness and, on these and many other Bolens products as well, Mueller Brass Co. "600" gears help make possible that fine performance.

Mueller Brass Co. "600" bearing bronzes are available as forgings, or in rod form. They provide unusually high tensile strength, a dense structure, good resistance to corrosion, and excellent bearing properties. Because of their good machining qualities, the "600" series bronzes can be finished readily—usually at substantial savings in COST.

It will pay you to investigate these alloys for your products . . . why not write today for full information.





Bolens' Ridemaster riding model garden tractor incorporating an 8⅝" diameter "600" bronze gear.

and TILLERS prove

CO.

Bolens' Super Mustang rotary tiller incorporating a 25-tooth "600" series bronze worm gear.

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Mueller Brass Co. Forgings Engineering Manual H-58565 ☐

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"600" Series Bearing Alloys Engineering Manual FM-3000 ☐

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198

40 MUELLER BRASS CO. 1917 1957

MUELLER BRASS CO.

PORT HURON 22, MICHIGAN

METALS AND ALLOYS REVIEW

by FRANK M. LEVY

Vice-President and Director of Research

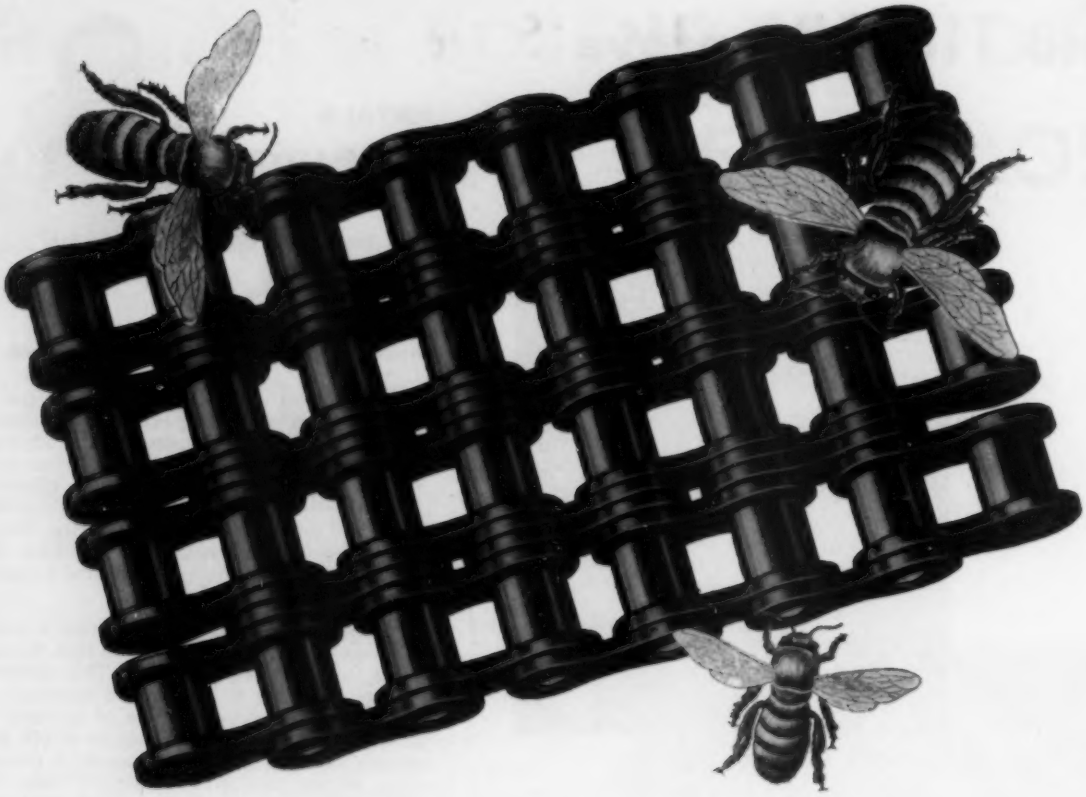
One of the most interesting things about our 600 series bearing alloys is the great variety of products in which they find application. In the advertisement to the left you can see how the Bolens people put 600 gears to work in their rotary tillers and garden tractors. Those gears are big, take a lot of abuse, and meet the job needs perfectly. We also make a lot of small parts, too, that have been specified because of the many unusual properties of this series of alloys.

One good example that comes to mind is a shaft bushing on a rotary selector switch that we make for an instrument manufacturer. This selector is used for switching sound-powered telephone circuits aboard Naval vessels. One of the most important considerations in the choice of 600 alloy for this bushing was its resistance to abrasive action on and against a rubber "O" ring. The acceptance test required a stainless steel shaft riding in the bushing to rotate "dry" for a minimum of 50,000 cycles consisting of 360° rotation clockwise followed by a 360° rotation counter-clockwise. The "O" ring must still form a watertight seal at the end of the test. Our 602 alloy was the only one of several materials tested that met the specs. That was pretty good evidence in itself of resistance to abrasion, but, in addition, this customer also found that the use of 602 eliminated the headaches they previously had with seizing and galling.

The pounding action caused by the indexing mechanism attached to the shaft used to give them no end of seizing troubles. The chief product engineer is extremely happy about the way our alloy is performing. Mention was also made of the fact that the corrosion resistance of 602 was mighty impressive. In this application, the alloy passed the 200-hour Navy salt spray test with flying colors.

So, big or small, it seems that there is no end of applications for 600 series alloys. We even have parts working in a machine that slices frankfurters as well as gears in fishing reels. So, it seems that 600 runs the gamut from "red hots to reels". Well, it looks like the end of the page is here again, so I'll close for now. However, if you have any problems or questions about non-ferrous alloys or you're having trouble getting desired performance from a part, why not drop me a line here in Port Huron, and possibly I can be of some service. Send a part print along if you like, and we'll be glad to make proper recommendations.

Thanks again for your time.



FACTS OF LIFE . . .

Facts which concern the designer of modern equipment are top efficiency, adaptability and minimum over-all cost.

Whitney's Self-Lubricating Single and Double Pitch Roller Chain and F-R (fatigue resistant) Processed Roller Chain are design advancements answering these needs for machinery manufacturers and users in many industries.

First, Whitney's amazing Self-Lube Chain outlasts regular chain by as much as 5 to 1 under toughest field conditions of continuous exposure to dust and moisture. Here, Whitney's exclusive sintered steel chain bushings "oil cleanly from the inside" . . . are prelubricated for life, cannot trap abrasive matter that cuts chain life. Ideal for applications in food, drug, textile and many industries where external chain lubrication is not practical or desirable.

Whitney's exclusive "F-R" (fatigue resistant) Processed Roller Chain is establishing new service standards for durability, particularly on problem drives involving unusual operational conditions, stresses and heavy shock loads. This performance comes from the exclusive Whitney "F-R" process which offsets excessive operational stresses in the chain.

These new dynamic, balanced chain designs serve better, longer and at less over-all cost. And so does the entire Whitney line of A.S.A. Roller, Silent and Conveyor Chain Drives . . . all precision engineered for top quality.

Whitney Field Engineers provide nation-wide consultant service, backed up by company operated warehouses and alert Whitney Distributors offering a complete off-the-shelf stock service. If you want RESULTS specify WHITNEY CHAIN.

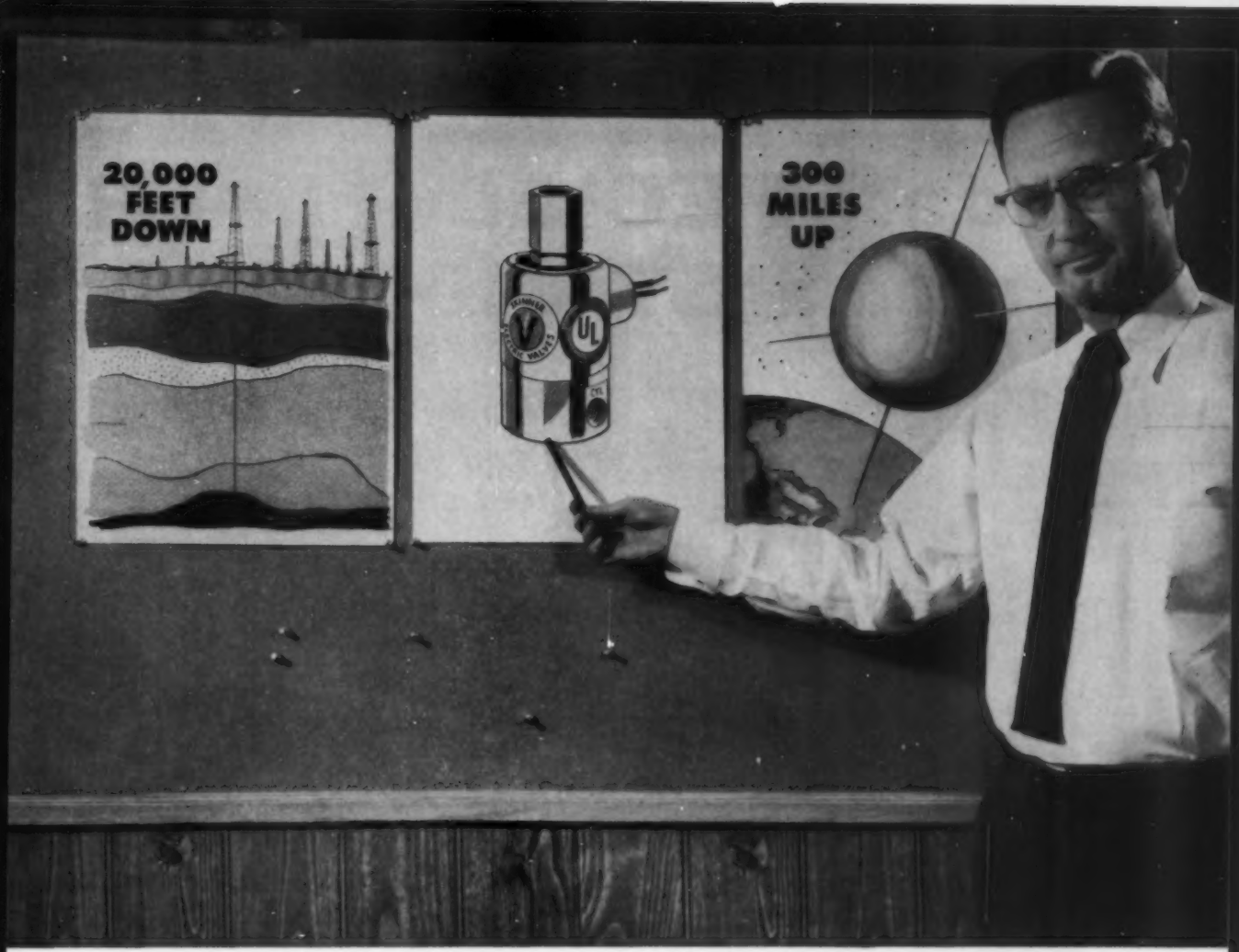
CREATORS OF SELF-LUBE CHAIN

Whitney

CHAIN COMPANY

204 Hamilton St., Hartford 2, Conn.

ROLLER CHAIN • SILENT CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS



The versatile design of Skinner Solenoid Valves makes their applications almost unlimited

Skinner Solenoid Valves have such great versatility that no one, not even their makers, knows the full extent of their applications. The range of their extremes demonstrates this vividly. One Skinner valve is being used in an instrument in Texas oil wells that tells the nature of earth strata 20,000 feet below the surface. Another one will be used to help launch the satellite that soon will be circling the globe.

If you have a problem that a solenoid valve might conceivably solve, we urge you to talk to a Skinner representative. Fill him in on the nature of your application. He'll be glad to work with you in selecting a valve that matches your requirements as to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings.

For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 454.

Skinner Solenoid Valves are distributed nationally

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN
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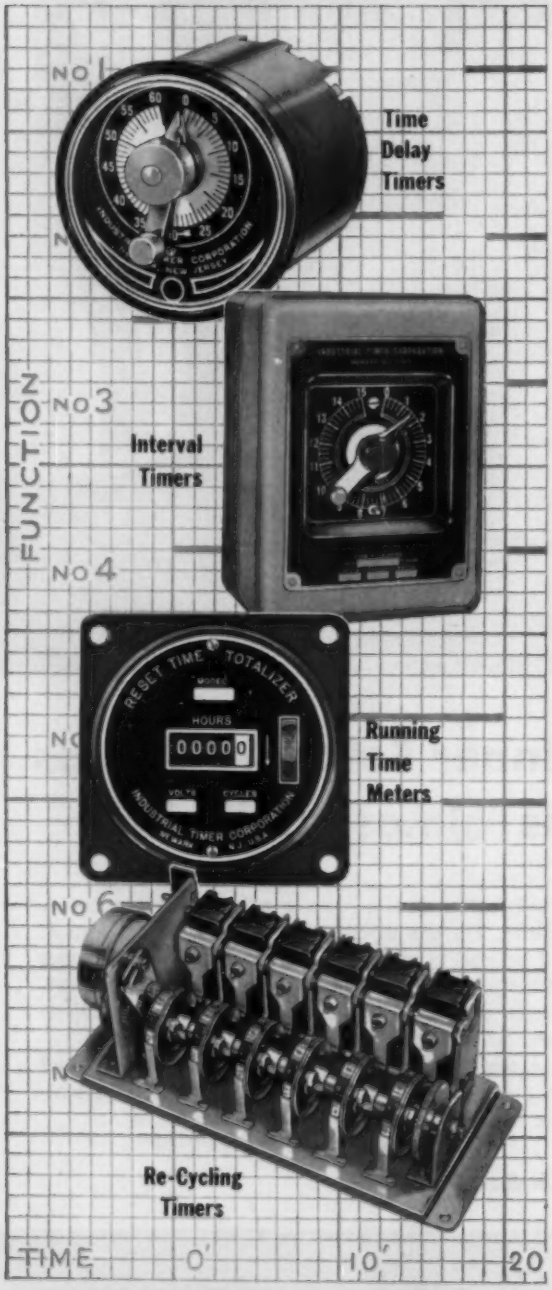
105 EDGEWOOD AVENUE

Need a "SPECIAL" TIMER ...need a "STANDARD"?



Here's why WE can give you the fastest service

When you want a timer, you want one that fits your needs 100% — and you want it *fast*. Get in touch with Industrial and you'll get both. Because:

In our 20 years of experience, we have developed over *a thousand combinations* from our 17 basic types, to meet the widely varying needs of our customers. Therefore — many jobs that would seem to require a "special" timer are in fact a "standard" timer with us. Here is one tremendous saving of time for you.

When you *do* need a special timer, this same wealth of experience goes to work for you at once to design it. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why requests for special timers can be filled without delay.

Each method — designing for a standard timer or for a special timer — has its advantages. Designing for an already available timer means lower costs, faster service, simplified replacements.

Designing for a special timer has its advantages too. It means you'll fulfill your needs 100% — no need to limit your designing horizons. Either way — standard or special — you'll get the timer you want most promptly from Industrial.

Or perhaps you need quick service on timers for automatic controls. Here too Industrial Timer is your first source of supply. For in this field Industrial has a big head start. True, each automatic control job is a bit different from the rest. But the record shows that our years of timer experience has given us the special knowledge it takes to give you the right answers in near-record time.

So, for the utmost in all-round timer service, it's Industrial that offers you this outstanding combination: deliveries "Immediate on Standards . . . First on Specials." Plus the experience of one of the foremost group of timer engineers in the nation.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
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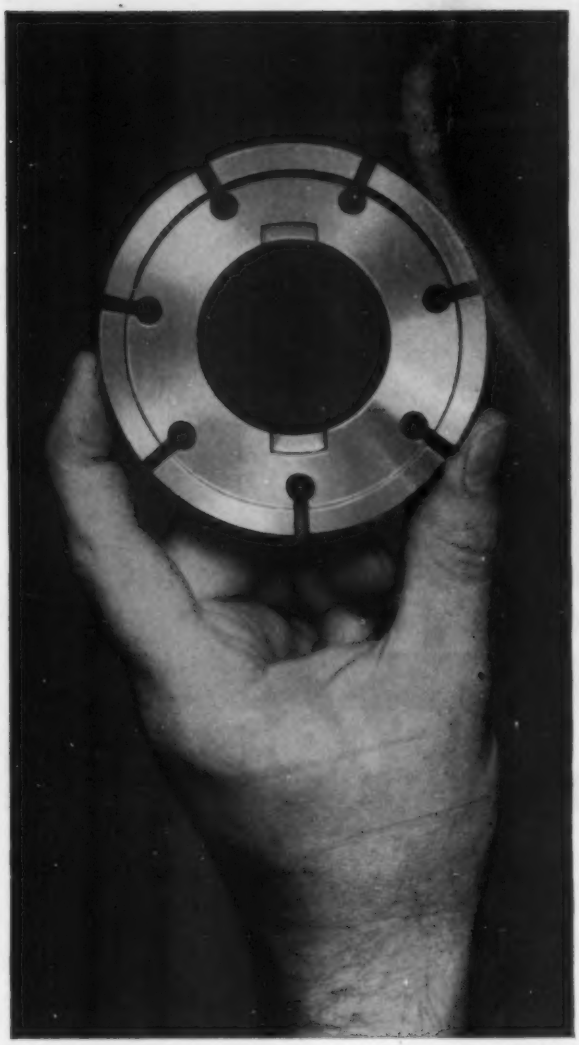

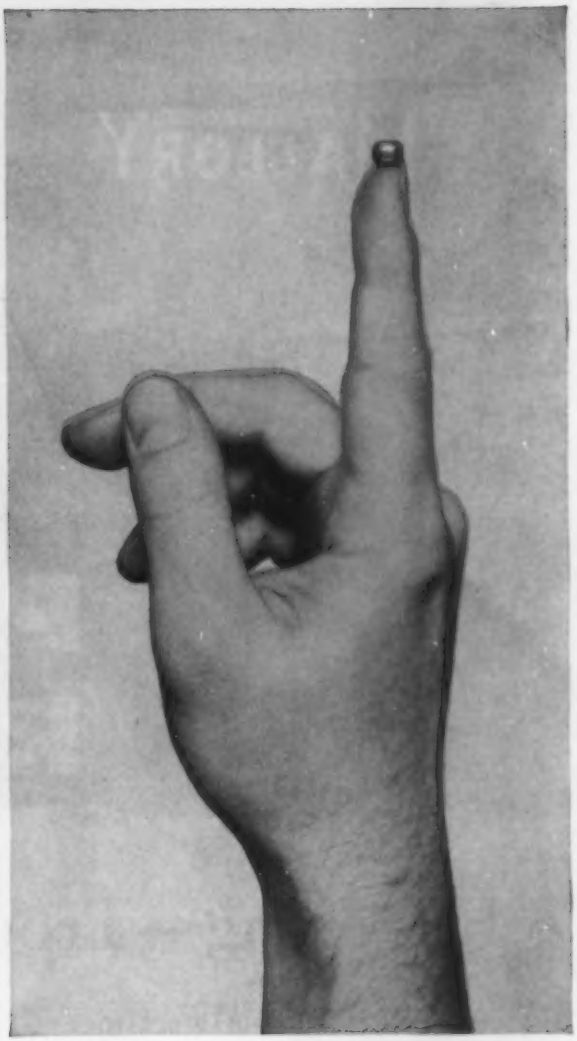

Does *weight* limit use of metal powder?

One of these metal powder parts is light, the other heavy. And while each varies widely in appearance and characteristics, *both* were easily produced by Moraine Products from metal powder.

Unit costs are less because each part could be mass-produced in a single press operation. Yet, the closer-than-ever tolerances that resulted in improved on-the-job performance were maintained.

Moraine Products has the experience gained from the production of hundreds of millions of metal powder parts in an infinite variety of shapes and sizes. Countless application problems have been solved through our experience in powder metallurgy. And, because we recognize the limitations as well as the advantages of metal powder, each specific assignment is studied and judged individually.

When we accept a job to make metal powder parts, it is only after thorough study has shown that the customer will receive parts of the highest uniform quality for dependable end-product performance. Of course, on-time delivery is assured, regardless of quantity.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials —Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

For Long—Trouble-Free Service

★ **VITREOUS ENAMEL TUBULAR RESISTORS**
In ratings from 3 to 200 watts.

★ **AXIAL LEAD RESISTORS**
In ratings of 4 and 7 watts.

★ **ADJUSTABLE VITREOUS ENAMEL RESISTORS**
In ratings up to 200 watts.

★ **CEMENT COATED RESISTORS**
In ratings from 5 to 200 watts.

★ **VITREOUS ENAMEL AND RW TYPES**
To meet Military Specifications.

For wire-wound resistors to meet exact circuit requirements—with the performance and ratings you need—look to Mallory. Mallory power resistors incorporate many design features to assure superior life, high physical strength, and ability to withstand thermal shock.

Mallory power resistors are available in a wide range of physical sizes, power ratings, coatings—to fit a wide variety of applications. A consultation with a Mallory resistor specialist can help you select the type best suited to your specific circuit design.

Complete information and data may be had by requesting Catalog 79-8.

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Parts distributors in all major cities stock Mallory standard components for your convenience.

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify CASE HARDENED CHROME PLATED PISTON RODS

On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify "TEFLON" WIPERS

On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

Specify TEFLON HYDRAULIC ROD SEALS

On all Hydraulic Cylinders

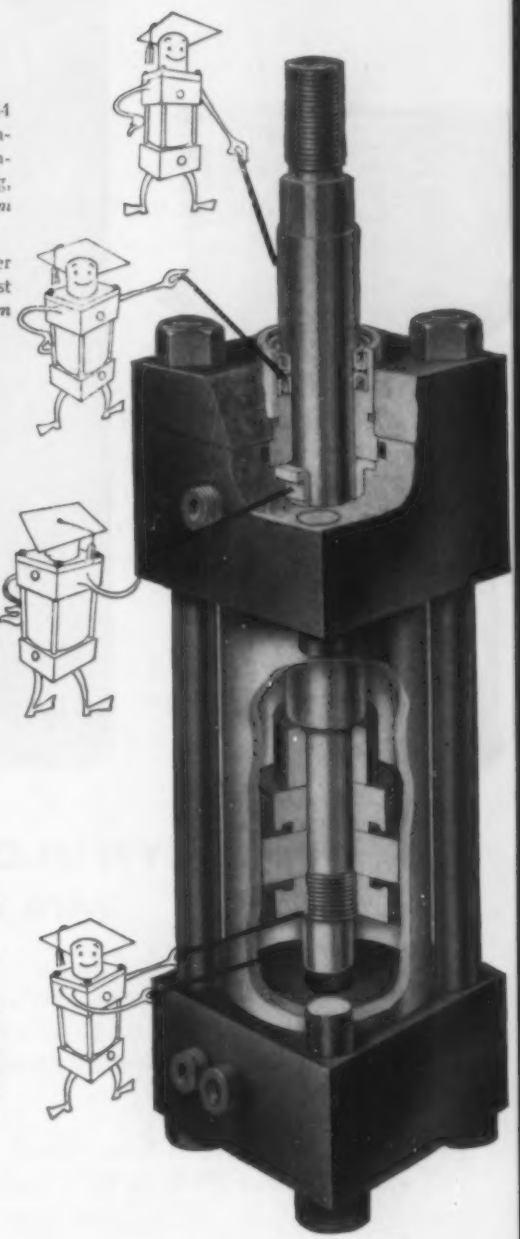
Specify RUST RESISTANT SURFACES

On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



NOTE. On all Miller Hydraulic Piston Seals: Leather Cup Seals are *standard*, Piston Ring Seals are optional at *no extra cost*, and "Teflon" Cup Seals are available *at extra cost.*

You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)_____

"On all our future cylinder requirements, please specify the above quality features."

Signed_____

Title_____

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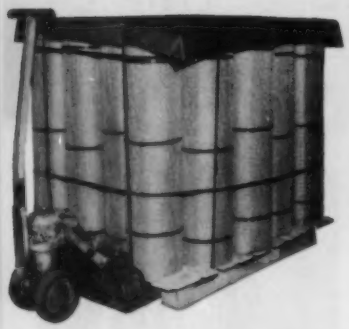

How **REYNOLDS** packs new savings into wire cloth shipments

• Palletized packaging for wire cloth, successfully developed by the Reynolds Wire Division of National-Standard, is now saving customers plenty of time and dollars.

Note in the photographs how rolls of slit and full width material are both mounted on non-returnable pallets. Advantages and savings accrue all along the way.

For example, there's far less chance of damage in shipment. And think how much faster, easier, these unit loads can be handled on arrival . . . in and out of storage . . . and right to production operations.

So chalk up another extra for Reynolds' service . . . and find out what this new packaging method can mean to you! Find out, too, what Reynolds means by quality control and uniformity in wire cloth manufacture. It pays.

NATIONAL NS **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *fine wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *high and low carbon specialty wires*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

FREE! New Full-Line Catalog of ALEMITE Lubrication Fittings!

Here is Alemite's new free catalog of the most *complete* line of fittings on the market! A simple, handy guide to fast, easy selection of the right fitting for every requirement. Contains detailed drawings of all Alemite fittings including the famous Alemite "Red-Ball" Hydraulic Fittings. Also lists many types of fittings that have been developed for special purposes—including relief fittings, measuring fittings and drive fittings. Complete with individual dimensions—ready for transfer to your own blueprints. Fill out the coupon below. Send for your new full-line catalog of Alemite Fittings today!

Only Genuine Alemite Red-Ball Fittings Offer These Four EXTRA Advantages!

1. Flat top with clean, dirt-cutting edge bites through dirt and old grease instantly!
2. Made *armor-hard* to resist nicks, scratches, distortion!
3. Tip has rounded contour to give extra working angle. No ridges . . . coupler won't slip off in tight quarters!
4. Extra-thick wall gives unequalled strength—withstands hard field service!

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Please rush me your new, complete catalog of Alemite Lubrication Fittings—*free* of cost or obligation.

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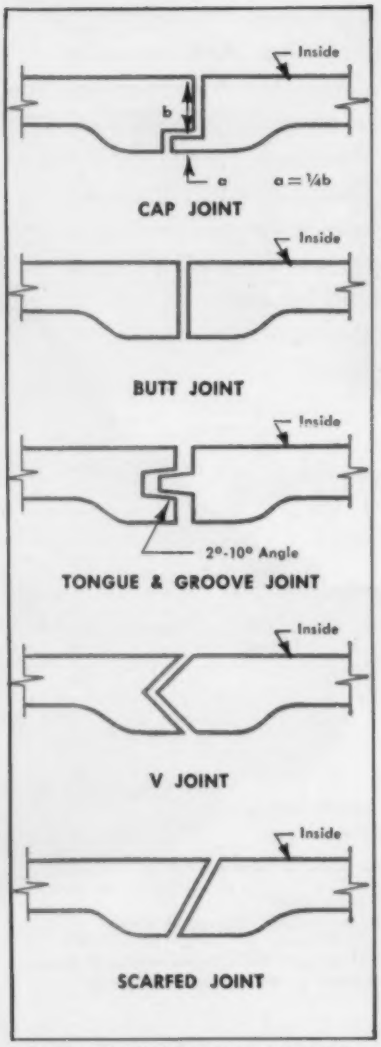
Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PROPER BONDING OF STYRON PARTS REQUIRES THOROUGH STUDY OF ADHESIVES



TYPICAL ADHESIVE JOINT DESIGNS FOR STYRON

Design of the joint plays an important role in the effectiveness of the adhesive, the appearance, and the ease and cost of the assembly. Design also determines whether the adhesive will be stressed in tension or in shear when under load.

ADHESIVE JOINT DESIGN CRITICAL IN OBTAINING MAXIMUM STRENGTH, DURABILITY AND APPEARANCE

The design of adhesive joints for Styron® plastic assemblies is dependent upon a thorough knowledge of the solvent and chemical action of the adhesive to be used. Through Plastiatrics studies, under the direction of Dow Plastics Technical Service, exhaustive tests have been made on adhesives for Styron. With this information, plastics engineers can more intelligently approach the problem of adhesive joint designs.

Most common of the adhesives studied are the solvent types. They are classed, generally, as fast, medium, and slow drying. Choice of a solvent adhesive is governed largely by the requirements of the finished part. Factors such as appearance, strength and production time must be considered when selecting this type of adhesive.

Certain joint designs require more viscous adhesives. These are made by adding resins, plasticizers and other modifiers to solvents. These adhesives are used when better watertight or airtight seals are required.

Although the objective of the studies was to determine the characteristics of adhesives for Styron and test the effectiveness of various adhesive joint designs, other valuable data was collected. Toxicity of these solvents must be considered in order to protect those who work with them. In addition, various methods of adhesive application were examined.

Plastiatrics studies and research continue in this and similar areas in an effort to find practical solutions to problems in plastics engineering. Determining the desirable properties of adhesives for Styron is just one of a series of such studies. For your copy of the technical bulletin "Adhesives for Styron" and a list of other areas now under investigation, write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department PL1541G.

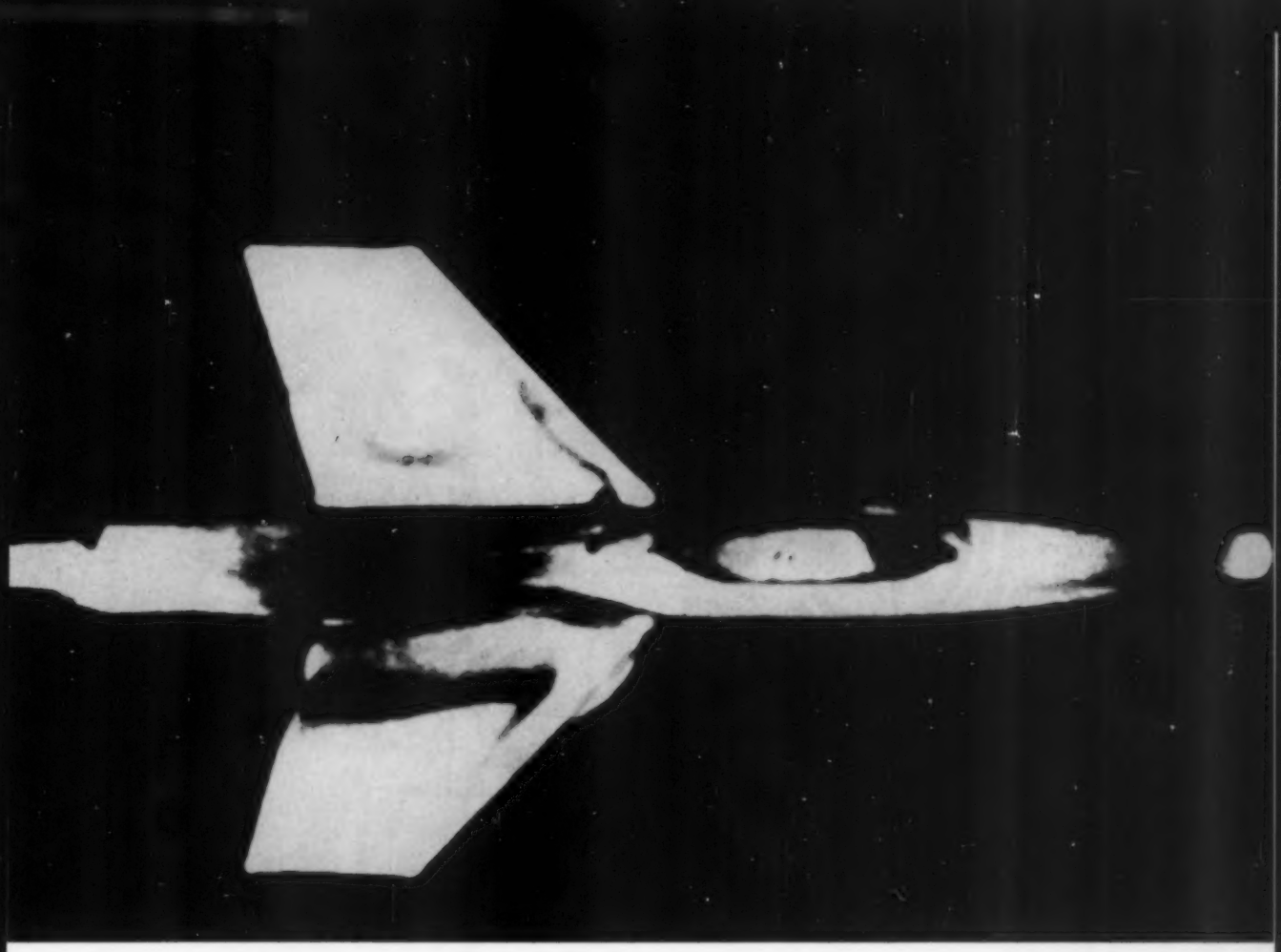
AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
- STYRON 666
- STYRON 665 (Extrusion)
- STYRON 688 (Easy Flow)
- STYRON 689 (Easy Flow)

HIGH IMPACT
- STYRON 475
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 480 (Extra-High Impact)

HEAT RESISTANT
- STYRON 683
- STYRON 700

YOU CAN DEPEND ON DOW



thermal thicket

The thermal barrier which now limits the speed of ultra high speed aircraft can be cracked. Needed: Structural components of elevated temperature alloys. Problems: Finding the right alloys; making them easy to forge and machine with regular production-line tools; maintaining uniformity of physical properties in production lots.

Right now, Carpenter is producing elevated temperature alloys which set new standards for consistent ability to meet tough aircraft specifications, high quality, improved forgeability and machinability. Engine builders find them ideal for many critical parts. Forge shops can work them to closer tolerances, get better finishes that require far less than usual machining. Work goes faster. Rejects are fewer.

You can get the full story of these alloys — their application, fabrication and engineering properties — in the new booklet, "Carpenter Alloys for Elevated Temperature Service". Get your personal copy by writing on your Company letterhead. The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

the state of the union is excellent

Injection-molded CYCOLAC parts have exceptionally strong weld lines

THE PERFECT RESIN
FOR THE MANUFACTURE
OF ANY PRODUCT
THAT DEMANDS

HIGH IMPACT STRENGTH
•
LIGHT WEIGHT
•
NON-CORROSION
•
CHEMICAL RESISTANCE
•
EASY MACHINEABILITY

The excellent knitting properties of CYCOLAC reduce stress failures around inserts and along flow lines. Especially adaptable for producing high strength pipe fittings, frames, rings, and open-face parts. High impact-resistance, good dimensional stability and high gloss.

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MARBON CHEMICAL . . . ***Precision Resins for Precision Made Products***

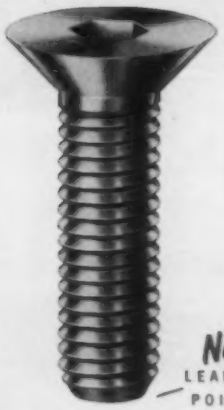
The BUY word for Socket Cap Screws is ALLEN

The *easy* way to make sure of greater strength, better fit and uniform quality in socket cap screws is to order "not just Allen-type but genuine ALLEN."

PRESSUR-FORMING

The latest improvement in the cold forging method originated by Allen. The tough Allenoy steel fibers are preserved continuous and uncut.

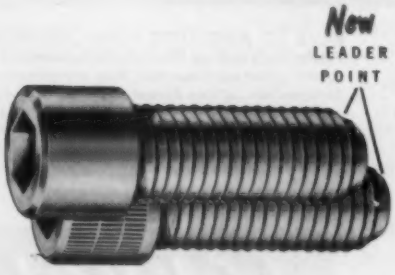
GRIP HEAD CAP SCREWS
The world's easiest starting, straightest driving, firmest holding cap screws.



FLAT HEAD CAP SCREWS
For firm fastening with flush surfaces. Especially adapted to fastening thin plates and sheets.

BUTTON HEAD CAP SCREWS
Produces smooth streamlined appearance where countersinking is impractical.

STAINLESS STEEL



Bright, non-corroding high tensile strength type 18-8. 151 popular sizes (NC & NF) with Smooth Heads *available from stock*. Also standard with Grip Heads in many popular sizes.

THE ALLENUT

Provides a ready-made threaded hole for use with cap screws in soft materials and for repair applications. Endless uses for compact design, space saving.

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Take advantage of their large stocks and fastener experience. Write direct for General Catalog G55.

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ALLEN HEAD

Five small Farval systems protect world's largest adjustable-rail milling machine

FARVAL—
Studies in Centralized Lubrication
No. 199

KEYS TO ADEQUATE LUBRICATION—
Trailer truck and car illustrate the tremendous size of this great machine tool. Red key-arrows indicate two of five Farval systems. Whenever you see this sign of Farval you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.

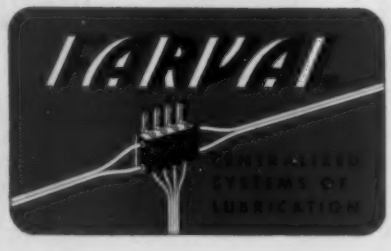
THIS 615-ton milling machine, installed at Schenectady, machines steam-turbine-generator parts up to 18 feet wide and 16½ feet high to close tolerances.

Vital to its smooth operation are five manual Farval systems which lubricate the rail nuts on the cross rail. Two of them are visible in the photograph. With Farval, accurately measured amounts of oil or grease can be delivered to bearings whenever needed.

Five small Farval systems are an insignificant part of the cost of protecting the $1.5-million investment in this world's largest milling machine.

You, too, can protect your machines inexpensively with Farval. Why not investigate, then invest! Just ask for Bulletin 26-S. Our representative will call at your convenience. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



Perspectives

IN DESIGN AND DEVELOPMENT

AIRCRAFT COMPANY DIVERSIFIES TO NUCLEAR FIELD

Some 2½ years ago Martin Company of Baltimore, a well-known name in the aircraft industry, decided to enter the expanding nuclear field. While the company had been doing work in the government's aircraft nuclear propulsion program, this new, completely independent division was formed to manufacture air-transportable power reactors of the 1000-5000 kw range, as well as some larger stationary 15,000 kw units. To make such a venture profitable within a reasonable period, Martin's main problem was to build the necessary technical staff.

MANPOWER PROBLEM

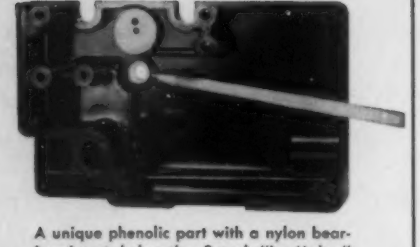
"One of our earliest convictions," according to T. F. Nagey, General Manager of Martin's Nuclear Division, "was that the work of the new division could proceed with men having a sound training in basic scientific and engineering disciplines, heat transfer, for example, plus a certain amount of nuclear technology theory." The problem of finding these men suggested several approaches: (1) Hiring experienced men from other companies. "This was turned down," says Nagey, "because we felt that it would require the efforts of two of our trained technical personnel to encourage one interested applicant to join the nuclear division. Meanwhile, these men would not be doing productive technical work themselves." (2) College recruiting: "Too few schools with either undergraduate options or graduate programs in nuclear technology." (3) Hiring university professors or men from government facilities like the AEC: "This would be mass suicide," says Nagey." "Any industry can not survive, least of all this one, if it proselytizes in these two areas."

EDUCATIONAL DO-IT-YOURSELF

"The structure already existed in the company for the plan we had in mind," says Nagey. "Why not use scientists and engineers of our own to teach, on an organized basis, interested engineers in the other divisions? Martin had long offered evening courses for engineers who desire to advance themselves. It was a simple matter to arrange a series of formal courses to extend the transferred engineer's basic education into the nuclear field. About 15 courses in all were included, and as the plan now operates, the engineer may take those courses of interest to him, or those which his needs dictate, provided that he has the prerequisites for each, and does the assigned homework. Unfortunately, we do not have enough instructors, and we set a limit of 25 students per class. As a result, each engineer will take a course according to his supervisor's priority rating of the men in his department."

Some of the courses available in Martin's nuclear program are: radioisotopes techniques; physics review; radiation hazards; survey of chemical structure; physical chemistry; introduction to nuclear technology; polymer chemistry; advanced nuclear technology; and nuclear reactor engineering.

(Continued on page 131)



A unique phenolic part with a nylon bearing insert helps the Servel "Ice-Maker" make ice in a new way and in a new shape.

NOW! ICE CUBES MADE *automatically!*

Combined molding of thermoplastic and thermoset materials helps assure trouble-free operation

If your next refrigerator is a Servel Icemagic, you'll find it solves the problems of ice-tray handling. It *eliminates* the tray—makes tumbler-round ice "cubes" automatically.

Part of the story behind this revolutionary development is a unique plastic part. It's made of phenolic—mostly, that is. However a small nylon bearing has been molded into the phenolic part. As a result, this self-lubricating nylon bearing allows the ice ejector arm to rotate freely . . . eliminates oil and any chance of ice contamination.

This was quite a trick . . . combining nylon and a phenolic. One's a thermoplastic; the other's a thermosetting plastic that requires molding heat that will normally soften a thermoplastic. To make a molding from both materials was like putting oil and water together. However, by selecting special formulations, and molding under mechanically contrived temperatures and conditions, Chicago Molded *did* the trick.

Whatever your new product needs, you'll find it pays to call in Chicago Molded. CMPC engineers *know* plastics, and they know how to help you make your product more saleable, yet less costly.

If you are interested in new plastic developments, let us send you a complimentary subscription to Plastics Progress. No obligation, of course.

CHICAGO MOLDED PRODUCTS CORPORATION
1032 North Kolmar Avenue, Chicago 51, Illinois

NOTHING VENTURED NOTHING GAINED

The company program has no set length, is completely voluntary, and offers no specific rewards for enrollment. As Nagey says, "We hold out no carrots." However, each student will receive notification of his grades, and such information will be entered in his personnel files. As an added convenience, Martin foots the bill for supper in the company cafeteria directly after working hours, and classes begin shortly thereafter in the plant or at a nearby high school. The instructors, some of whom have had teaching experience, are paid extra for their work by Martin.

Nagey feels that the program has been highly successful. "Engineers from all parts of Martin are being transplanted into the Nuclear Division and perform productive work at the same time. Men completely untrained in the nuclear field once trained by us, have competed successfully in the division with men having previous nuclear experience. Many men become sufficiently interested to enroll in a Master's Degree program recently organized at Martin in conjunction with the Drexel Institute of Technology in Philadelphia. In fact, 30 to 35 per cent of the nuclear division's engineers who are taking courses are enrolled in the advanced degree program."

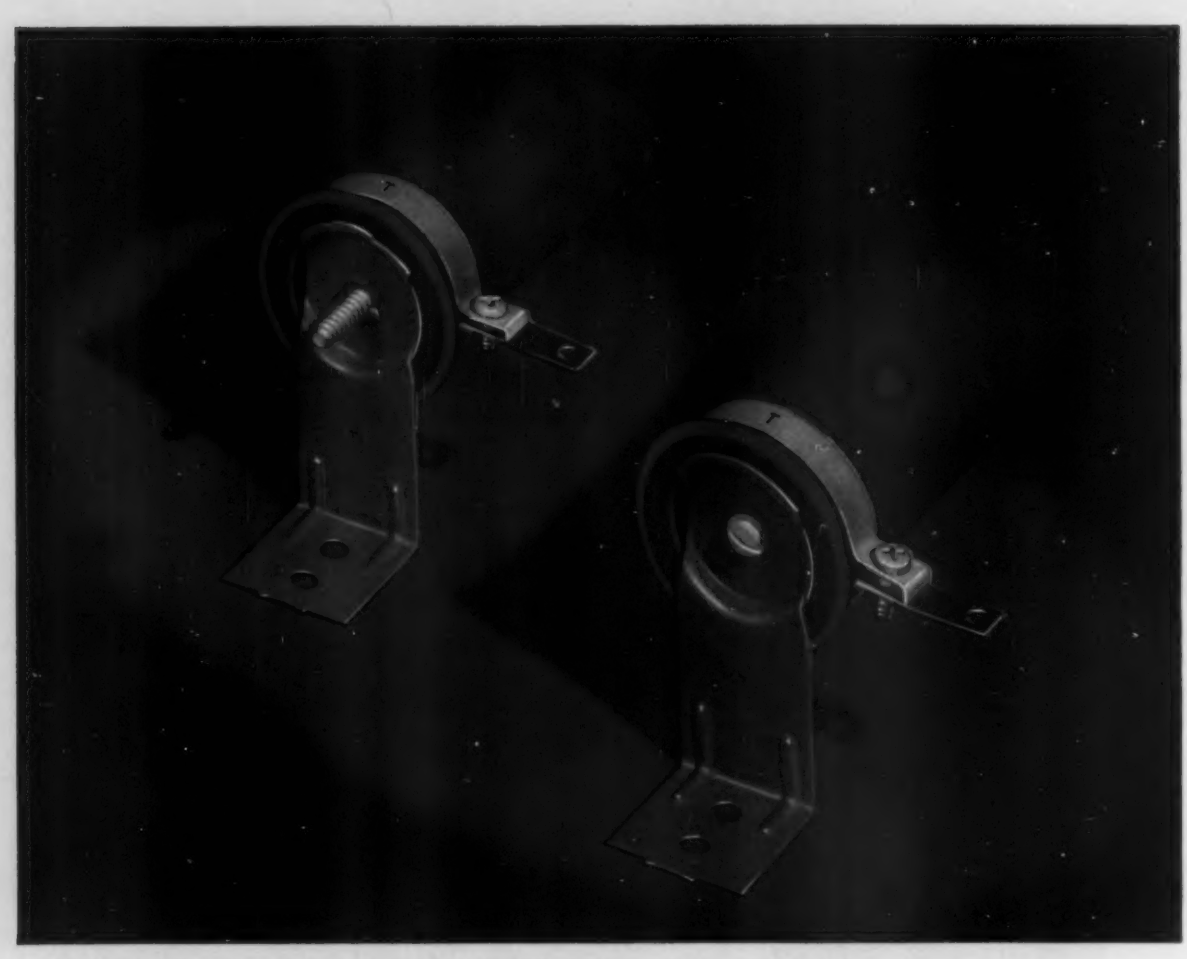
DIVISION IS GROWING FAST

While the company has the average turnover rate, it has become evident that the group of company-taught engineers in the nuclear field is the target of recruiters representing other companies in this field. The nuclear division grew from seven men, 2½ years ago, to over 300 now, and expects to have 500 by the end of the year. The division is organized into staff groups serving four various project groups: advanced design; materials research; general engineering; and nuclear engineering.

With the multiple-component, air-transportable power reactors, Nagey says, "We feel that we have made a significant contribution, because until recently, the prevailing opinion was that about 60,000 kw was the lowest feasible rating for power reactors. The primary market for such a reactor is the military, or remote locations where conventional power plant installations would not be practical. Both of Martin's reactors—the 1000-5000 kw air-transportable and the 15,000 kw unit—are of the pressurized water type which are limited by the availability of water.

The nuclear division acts as a consultant when requested by nuclear group in the aircraft division. The reverse is also true. At the outset, some metallurgists and radiation specialists in the aircraft division came over to the new nuclear division to help out and learn a little about the new department, but the stay was not permanent.

The division also operates a gamma radiation facility (see cover) for research on the effects of irradiation on materials. The aircraft division also benefits from this work. Already this facility has come up with some interesting developments in the monomer-to-polymer, and metal-to-polymer grafting. Also, progress is being made in the field of fuel element improvement, considered the most difficult part of reactor design. As for the future, Nagey is pleased to relate that, "We are now on the road to being self-supporting."



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How Apt Is a Machine?

Several years ago, we had the privilege of studying rather closely the operations of a numerically controlled milling machine at Massachusetts Institute of Technology. We worried then about some almost-human characteristics it exhibited, such as the ability to translate a formula into a 3-dimensional part without benefit of blueprint, or to duplicate in Cambridge in metal the idea of an engineer in Seattle or Capetown. We learned to use some new phrases such as "numerical control" and "information processing."

Now comes further word from M.I.T. that a new system of programming called the Automatic Programmed Tool System, APT for short (and very apt it is), has been developed. The APT system uses an English-like language to transmit ideas from human to machine, a precise, short language like that you'd use in talking to a dog. In short, every word always means the same thing, must—or the machine doesn't understand. Beyond that, when properly instructed, the machine can make a drawing of a part previously expressed only in numbers or formulas, or can translate that information into a part in metal. In fact, the "trainers" of the unit believe that shortly it will be able to accept instructions in terms of the physical requirements of a component. With these, it can specify the type and size of material required, and if supplied the material, will machine it to the proper dimensions within the necessary tolerances.

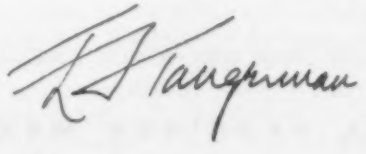
What is now handbook information can be fed into the machine, which will thereafter remember it and feed it back into the engineering calculations at the proper points. Thus the machine replaces the engineer who lives by the handbook alone.

In many respects, the machine (like the handbook engineer) harks back to the popular concept of the robot—a one-track mind that goes inexorably from simple command to finished piece. It thinks only in a straight line, as instructed. It has no human characteristics of frailty or error; give it correct data and it provides a correct translation in metal. Gone are fatigue, error, native ingenuity, woolgathering, and other purely human characteristics that change a design.

This implies, to us, several things. It means that a design concept can be made into a finished job with no wastage of time on human effort or emotion, that the idea of the engineer can be made real without error. It also means that the engineer (presumably human) may not err himself, that the idea he develops must be perfect. It eliminates one entire area of chance—the largest one, in fact. It makes impossible the fortunate mistake as well as the unfortunate one. It removes endless hours of sub-engineering drudgery, but at the same time sets a new, higher standard of performance—or the human falls behind the machine.

Say what you will, the idea is terrifying. Now a simple and logical human error, caused by recollection of an enjoyable motor trip, or dreaming of the utterly human problems of Richard the Lionhearted, can suddenly become solid metal with a curve where a straight line ought to be. There's no one to question the design—and no drawing.

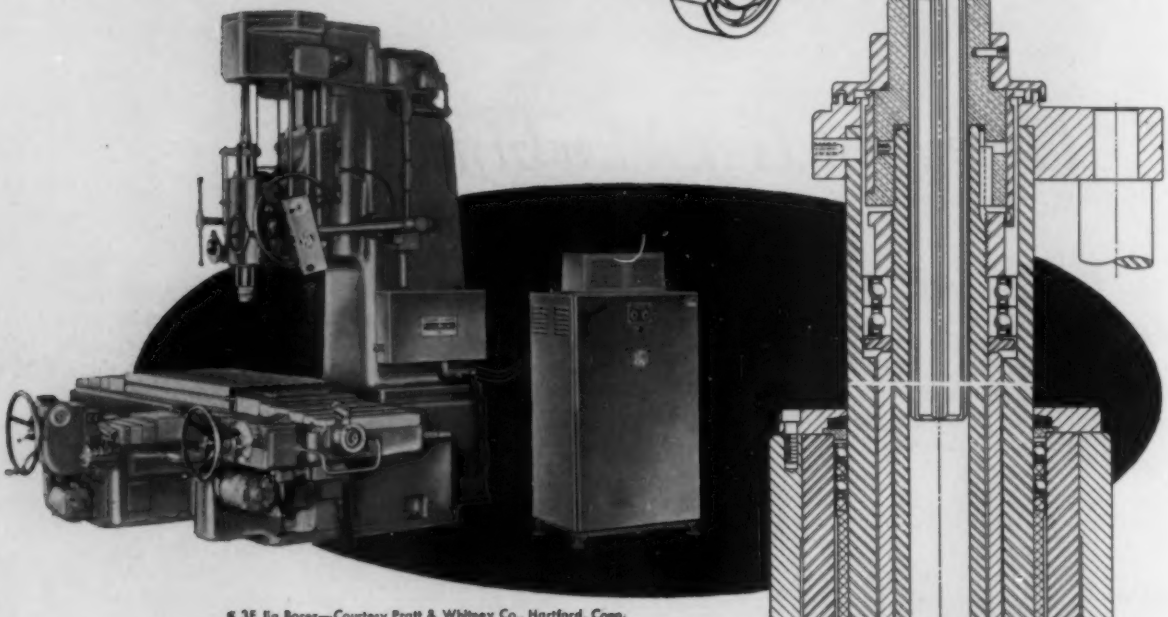
Are we, in effect, starting a parade of Juggernauts? Will we have machines so inexorable they mow down anything human in their path? Is it time we built in a headache, a heartache, or some other frailty so the machine remains understandable?



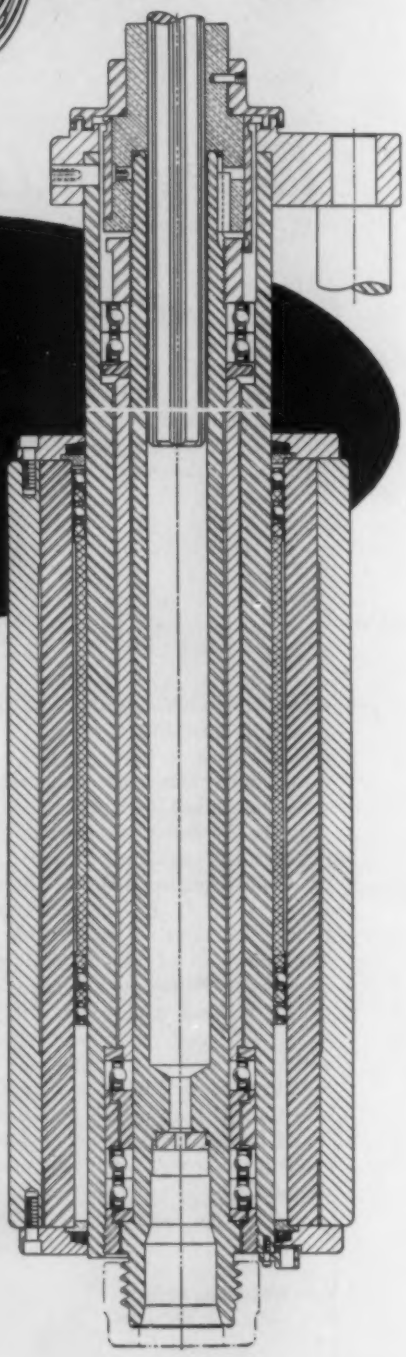
FACTS

about

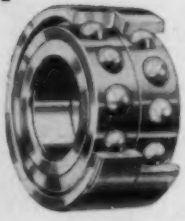
NEW DEPARTURE BALL BEARINGS



5 3E Jig Borer—Courtesy Pratt & Whitney Co., Hartford, Conn.



INVESTMENT IN PRECISION



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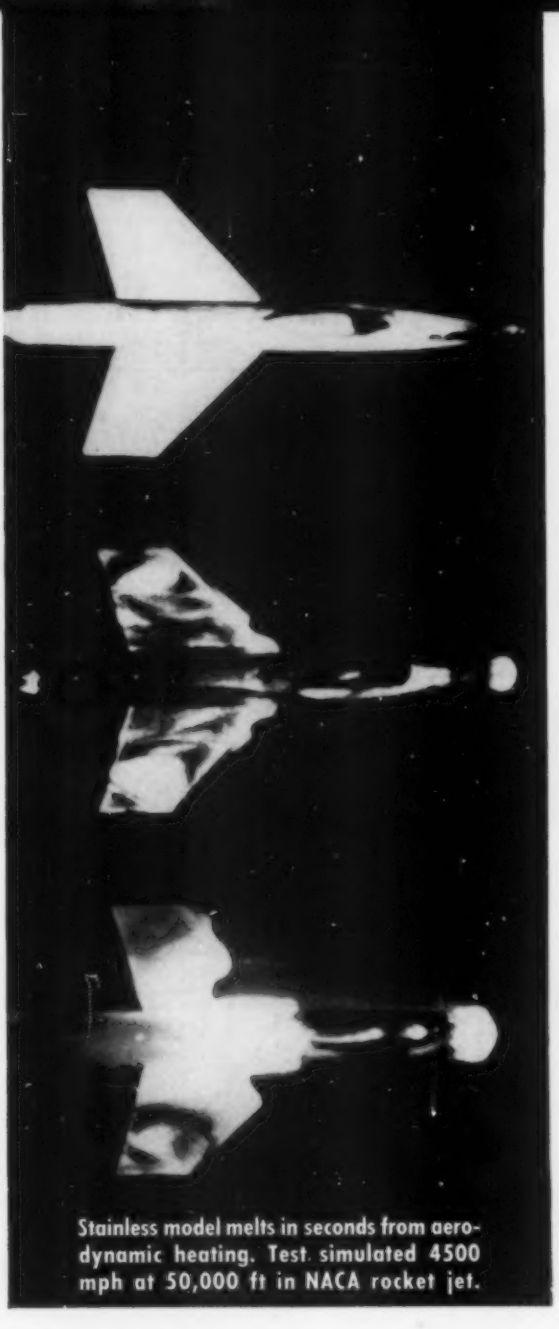

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HIGH-TEMPERATURE STAINLESS

eight alloys for

600 to 1400 F

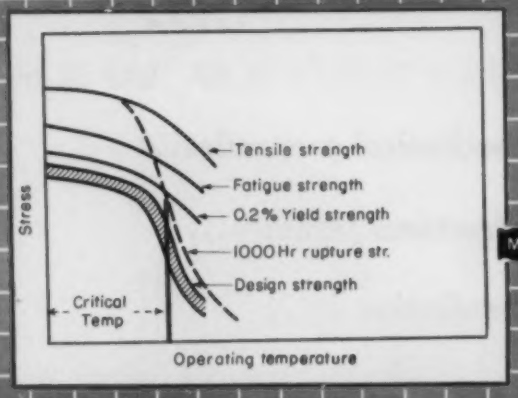
EDWARD A. LORIA,
Staff Metallurgist
Crucible Steel Co. of America

Precipitation hardenable stainless steels, both the austenitic and semi-austenitic types, have unusual characteristics at elevated temperatures. Although developed specifically for airframe and jet engine parts, these steels are useful structurally in any application where 600-1400 F operating temperatures are encountered. Presented here are recent pertinent structural data on 5 austenitic type steels and 3 martensitic alloys of the 400 series usable in this temperature range. Effects of heat treatment and cold reduction are also included.

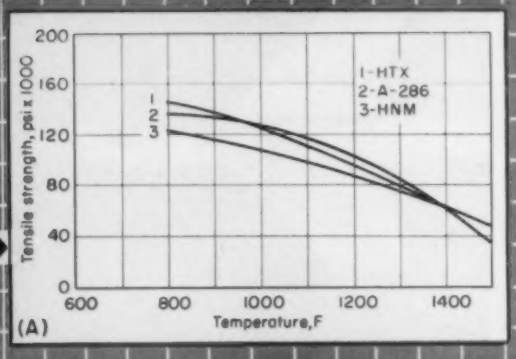
Structural stability data suggests these alloys be divided into two groups according to operating temperature. The "high" temperature alloys are those structurally stable in the 1200-1400 F range; "moderate" temperature alloys are those useful up to 1200 F. In the former category are the austenitic alloys HNM, HTX and A-286. The latter grouping includes the semi-austenitics: 17-7PH and AM-350 and the martensitics: 420, 422 and 422M. Chemical compositions for the 8 alloys are shown in Table IV.

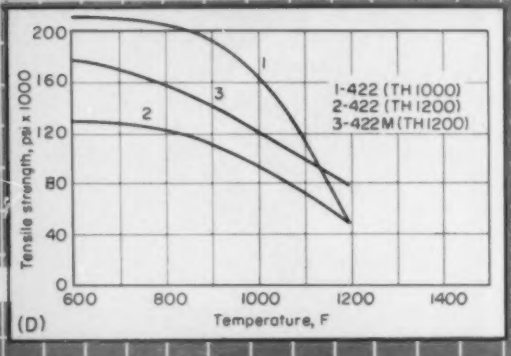
Austenitic Alloys

Austenitic steels achieve their excellent strength properties through the precipitation of chromium carbides and intermetallic carbides. HNM and HTX depend on phosphorus to produce precipitation, whereas A-286 contains titanium and aluminum for this purpose. At room temperature, tensile strength of these three ranges from 145-168,000 psi; yield strength (0.2 per cent offset) from

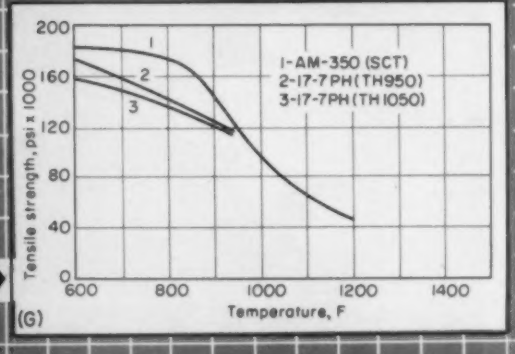


Martensitic





Semi-Austenitic



▲

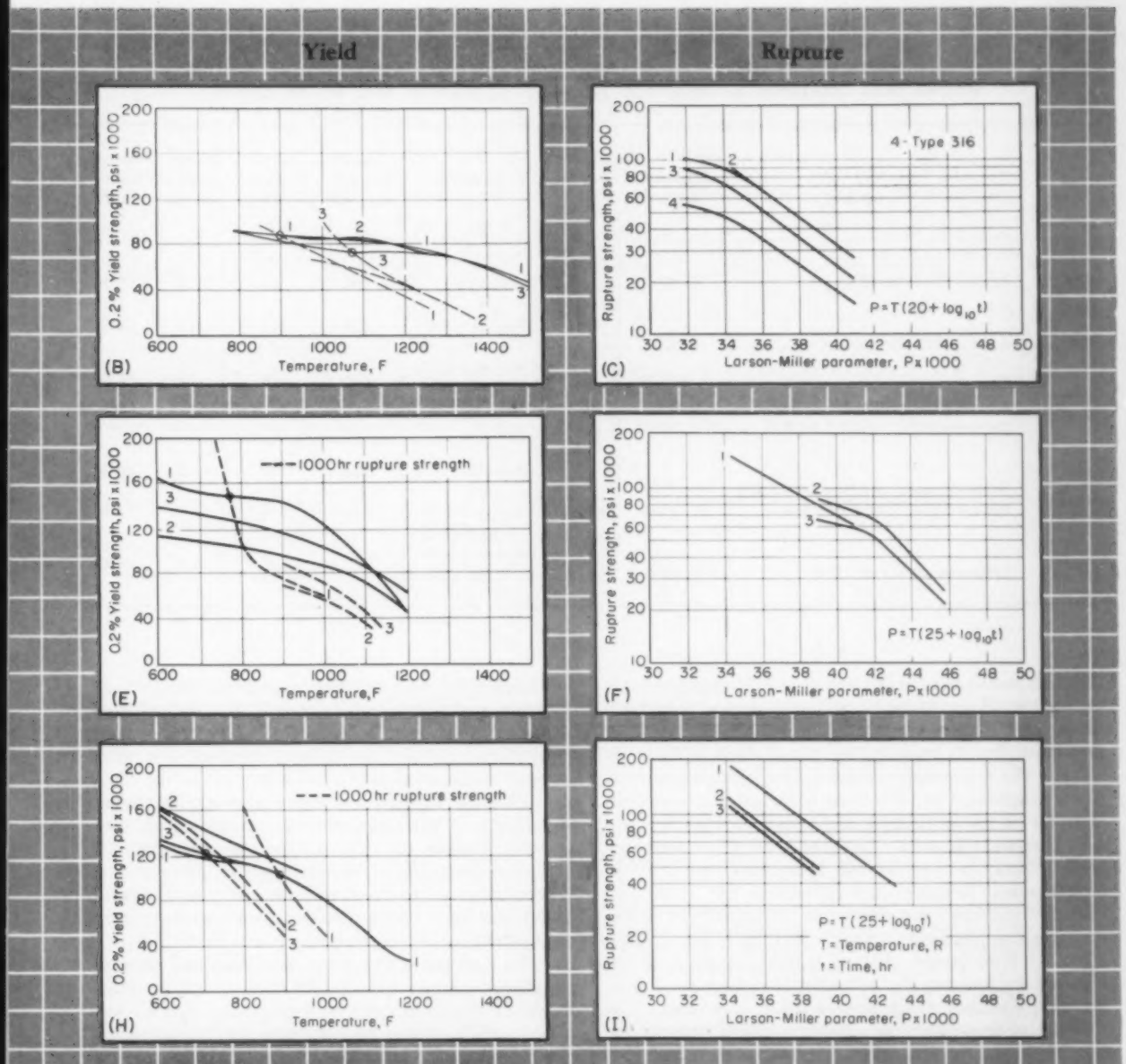
Traditional design criteria, tensile strength and yield strength, are valid to a certain temperature. Above this, creep strength and rupture strength predominate. Creep strength, the stress causing a specified deformation in a set time, is used where allowable deformation is small; rupture strength, the stress causing rupture in a specified time, is used where the criterion of failure is fracture. Shown above is the abrupt reduction in design strength dictated by intersecting yield and rupture strength curves. In designing above the yield strength, the intersection of fatigue strength and stress rupture curves may establish a different "critical" temperature.

▶

Fig. 1—Tensile, yield and rupture strength data compared for 3 high-temperature stainless steel alloy groups: austenitic, martensitic and semi-austenitic. Rupture strength at 1000 hr plotted on yield strength curves (B), (E) and (H) to indicate critical temperatures.

TABLE I—HEAT TREATMENT AND ROOM TEMPERATURE PROPERTIES

Alloy		Heat Treatment	Yield Strength, psi x 1000	Tensile Strength, psi x 1000
Austenitic	HNM	Solution treated at 2150 F, aged at 1350 F	124	163
	HTX	Solution treated at 2150 F, aged at 1550 F	124	168
	A-286	Solution treated at 1800 F, aged at 1325 F	100	146
Martensitic	420	Austenitized at 1875 F, tempered at: 600–800 F	190–205	240–260
	422	Austenitized at 1875 F, tempered at:		
		900 F, (TH900)	200	265
		1000 F, (TH1000)	160	228
		1200 F, (TH1200)	120	145
	422 M	Austenitized at 2000 F, tempered at:		
		1200 F, (TH1200)	140	177
Semi-Austenitic	AM-350	Annealed at 1750 F:		
		Sub-zero cooled at — 100 F, tempered at 850 F, (SCT)	152	198
		Double-aged at 1350 F and 850 F, (DA)	144	174
	17-7PH	Annealed at 1950 F, double-aged at:		
		1400 F and 950 F (TH950)	180	198
		1400 F and 1050 F (TH1050)	150	180



100-147,000 psi. Strength is produced by solution heat treatment followed by aging at lower temperature.

Room temperature strengths for austenitics are lower than for the other types; however, they retain tensile strength and rupture strength better at higher temperatures, so long as the aging temperature is not exceeded. Strength may be improved by lowering the aging temperature, but the permissible range of operating temperatures is correspondingly narrowed. Solution and aging temperatures for HNM, HTX and A-286 are given in Table I, together with room temperature tensile strengths.

Tensile and yield strength are correlated with temperature at (A) and (B) respectively in Fig. 1. Rupture strength as a function of temperature and time through the Larson-Miller parameter (c=25), with Type 316 stainless included for comparison, is shown at (C). Rupture stress for 1000 hours is plotted on (B) to show the temperature above which stress-rupture controls. Note that for A-286, rupture stress controls throughout. All these interpretations of design strength are generally used with an appropriate safety factor.

Martensitic Alloys

Certain Type 400 stainless steels can be heat treated to high strength levels and retain these properties well on exposure to high temperatures. These alloys depend, in large measure, upon a tempered martensitic structure for their maximum properties. Advantages of the martensitic

TABLE II—DIMENSIONAL CHANGES DURING HEAT TREATMENT

Alloy	Treatment	Change, in/in
HNM	Aged 1350 F for 16 hr	−0.0001
HTX	Aged 1550 F for 16 hr	−0.0001
17-7PH	Aged 950 F or 1050 F	−0.0006
	Refrigerated at −100 F for 8 hr	+0.0050
AM-350	Subzero-cooled and tempered 850 F	+0.0050
	Double aged, 1350 F and 850 F	+0.0040
422	Tempered 1000 F or 1200 F	+0.0025

TABLE III—EFFECT OF COLD ROLLING ON HNM AND AM-350 ALLOYS

Alloy	Condition	Tensile Strength, psi x 1000	Yield Strength, psi x 1000	Elongation, per cent	Rockwell Hardness
AM-350	Annealed	169	45	20.5	95 B
	Reduced 30%	223	210	2.5	42 C
	Reduced 30%, aged 850 F	224	224	3.0	45 C
HNM	Annealed	106	58	48.0	88 B
	Reduced 30%	149	138	14.0	35 C
	Reduced 30%, aged 1250 F	170	147	14.0	40 C

steels are their lower coefficients of thermal expansion and higher thermal conductivities. A disadvantage is the greater dimensional changes which occur in heat treatment. This important effect is compared for several alloys in Table II.

Type 420 is a straight chromium steel which produces, when austenitized at 1875 F air quenched and tempered at 650 F, a tensile strength of 250,000 psi with a 6 per cent elongation in sheet. Types 422 and 422M have less carbon (hence a more ductile martensite), but contain molybdenum, tungsten and vanadium for good hot strength. The latter two alloys were developed specifically for turbine applications, tempered at 1200 F and used to 900-1200 F in service. Higher tensile strength may be obtained by lowering the tempering temperature. Again, however, operating temperature range is narrowed.

Effect of temperature on tensile and yield strength for two of the martensitic alloys is shown at (D) and (E) respectively, in Fig. 1. The slopes of these curves indicate structural stability. Type 422 and 422M in the 600-900 F range display superior tensile strength to the austenitic HNM and A-286 alloys. Modified 422 retains quite high strength up to 1200 F. Stress rupture characteristics of the martensitics appear at (F), with the 1000-hr strength compared to yield strength in (E). Note that stress-rupture controls through the entire range for all except 422 tempered at 1000 F. Here, elastic behavior is the limiting factor to about 800 F. Comparing (E) and (B), the austenitic series appears useful to higher temperatures than the Type 400 series, although below 800 F, Type 422 (TH1000) has considerably higher hot strength.

Semi-Austenitic Alloys

Two martensitic alloys, AM-350 and 17-7PH are austenitic in the annealed condition. To be hardened to higher strength, these alloys require heat treatment first to transform the austenite into martensite, and then aging either to facilitate carbide precipitation or to temper the martensite matrix.

AM-350 is not a true precipitation hardening alloy; however, annealed ductility is converted to hardened strength by low temperature heat treatment plus tempering, hence its classification with the precipitation hardening alloys. Double aging can also be applied to AM-350, but this produces slightly lower properties. Hardening of 17-7PH is also accomplished by a two-step transformation. Typical heat treatment temperatures and resulting room temperature tensile strengths are given in Table I.

At (G) and (H) in Fig. 1 are shown elevated temperature effects on tensile and yield for these two alloys, stress-rupture data appearing at (I). Transposing 1000-hr rupture stress values to the yield strength plot shows the excellent performance of AM-350(SCT): a 1000-hr rupture strength at 800 F (161,000 psi) well in excess of the yield strength (112,000 psi) at this temperature; at 900 F, rupture strength (99,000 psi) almost equals short-time yield strength (103,000 psi). Short time yield strength can be used as the design criterion for 17-7PH(TH950) up to about 600 F; for TH(1050) temper, about 700 F is the limit. Lower density (0.276 compared to 0.286 for AM-350) however, gives a higher strength-weight ratio, making 17-7PH alloys usable for aircraft and missile parts up to 800 F.

Fabrication

Final selection of a high temperature stainless alloy frequently depends as much upon fabrication characteristics as upon strength. In the solution treated condition, A-286, HNM and HTX are soft and ductile, and may be formed readily. Alloys 17-7PH and AM-350 resemble the austenitics when fabricated in the annealed condition, though

TABLE IV—CHEMICAL COMPOSITION

Alloy		C	Cr	Ni	Mn	Mo	W	V	P	Ti	Al
Austenitic	HNM	0.30	18.5	9.50	3.50				0.23		
	HTX	0.45	21.0	8.50	8.50	1.50			0.23		
	A-286	0.05	15.0	26.00	1.35	1.75				2.00	0.20
Martensitic	420	0.37	13.4	0.15	0.40						
	422	0.22	11.7	0.70	0.65	0.95	0.93	0.25			
	422M	0.28	11.8	0.20	0.84	2.24	1.70	0.50			
Semi-Austenitic	AM-350	0.08	17.0	4.20	0.60	2.75					
	17-7PH	0.07	17.0	7.00							1.15

they work harden more rapidly as shown in Table III. Severe deep forming can be done only with an intermediate annealing process.

Sound welds can be made with HTX and A-286 with proper preheating, weld metal protection and heat input control. Ductile butt welds have been made with HNM using the shielded tungsten arc process. Both 17-7PH and AM-350 are weldable by conventional methods; however, heat treatment is required after welding to develop full strength. Joint efficiencies up to 85 per cent are possible in tungsten-arc welded 17-7PH after TH950. As welded strength of AM-350 is usually equivalent to base metal strength, but ductility is somewhat reduced.

Furnace brazing Type 422 produces high strength joints as the alloy is easily and completely wet by nicrobraze. Good capillary action permits close fits (0.0005 to 0.002 in.). Brazed joints tempered at 1200 F show efficiencies of 80 and 88 per cent at room temperature and 1000 F, respectively. Alloy 17-7PH is also readily brazed, but the brazing operation should occur at annealing, preceding transformation and hardening.

Growth or contraction occuring heat treatment of AM-350 and 17-7PH, as shown in Table II, must be considered when laying out parts to be fabricated annealed and subsequently heat treated. Where close tolerances are required, it is recommended that final machining be done after transformation treatment.

Stress-rupture curves (C), (F) and (I) of Fig. 1 permit comparison of many alloys on the basis of short-time tests. The Larson-Miller parameter combines the factors of time and temperature. Increasing the test temperature reduces the time to rupture. Thus an estimation of the stresses in long-time service can be made from short-time stress-rupture tests at higher temperatures. Such predictions are usually accurate to plus or minus 10 per cent in stress. Considering the many alloys under development, and the wide spectrum of operating temperatures desired, these techniques save many valuable testing hours. In using the stress-rupture curves of Fig. 1, note that the constant is 25 for (F) and (I), but is 20 for (C).

EDITOR'S NOTE: The following articles which have appeared recently in PRODUCT ENGINEERING are part of a continuing editorial program of design information on elevated temperature problems.

"Nitride-Bonded Silicon Carbide," February 1957 page 135, describes a specially bonded ceramic with improved hot strength and resistance to abrasive and corrosive environments. Shape and size factors, mechanical and physical properties.

"New Nickel-Free Stainless," December 1956 page 151, presents data on an austenitic stainless steel with nickel replaced by manganese and nitrogen to give improved strength and satisfactory formability.

"Magnesium-Thorium Alloy," November 1956 page 200, covers a new light alloy with high modulus-weight ratio for use in the 500-700 F range. Effect of elevated temperature on: tensile and yield strength, modulus, fatigue strength, creep strength and bend radius.

"Metals at Elevated Temperatures," October 1956 page 160, discusses the basic materials design question of what are elevated temperatures. Influence of high temperatures on a wide variety of metal properties; relative importance of fatigue and rupture strength; predicting long-time behavior from short-time data.

"High Temperature Materials," September 1956 page 186, reviews early development, alloy systems used, properties required, methods of evaluation and trends.

"Spring Materials for High Temperature Service," August 1956 page 186, compares 17 commonly used spring materials. Creep and fatigue data, recommended design stresses for light, medium and severe duty.

"Heat Resistant Cast High Alloys," February 1955 page 163, discusses strength and corrosion resistance under repeated thermal cycling above 1200 F.

Fig. 3—Barometer

Fig. 2—Single-leg mercury manometer.

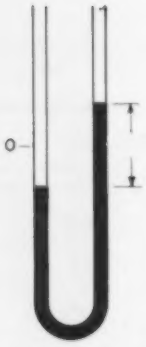


Fig. 1—Mercury U-tube manometer.

MEDIUM VACUUM as

Fig. 4—Bourdon-tube dial gage.

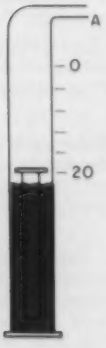


Fig. 5—Dubrovin vacuum gage.

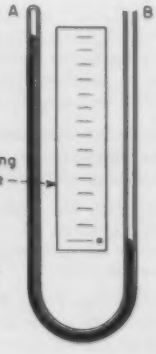


Fig. 6—Absolute pressure gage.

TABLE I—COMPARISON OF GAGES USED FOR PRESSURE AND NO VACUUM

Absolute Pressure			Mercury Column, in.	Water Column	
in. mercury	mm mercury	lb. per sq. in.		ft.	in.
0	0	0	29.92*		
0.1	1 2 3	0.02			
0.2	5	0.10			
0.3	7 8	0.16			
0.4	10	0.19			
0.5	12 13	0.25			
0.6	15				
0.7	16 19	0.31 0.37			
0.8	20				
0.9	22 24	0.42	−29		
1.0	25	0.48			
2.04	52	1	−27.87		
4.1	103	2	−25.83		
6.1	155	3	−23.79		
8.2	207	4	−21.75		
10.2	259	5	−19.71		
12.2	310	6	−17.67		
14.3	362	7	−15.63	−17.7	
16.3	414	8	−13.59	−15.5	
18.4	465	9	−11.55	−13.1	
20.4	520	10	− 9.51	−10.8	
22.4	570	11	− 7.47	− 8.5	
24.5	620	12	− 5.43	− 6.2	
26.5	670	13	− 3.39	− 3.9	
28.6	720	14	− 1.35	− 1.5	−18.3
29.92**	760**	14.7**	0	0	0

**Varies continually with the atmospheric pressure. *Approx. Barometer Reading.

The mercury column and the absolute pressure are dependent upon the atmospheric pressure which changes from time to time.
One micron = 0.001 mm. absolute pressure.

Atmospheric pressure can be a useful tool in the handling of materials and parts during manufacture or assembly. Vacuum cups can lift surprisingly large loads, simple suction circuits move fluids awkward to handle in other ways and atmospheric pressure applied to uneven surfaces simplifies molding and casting.

ORMONDE BOGERT
Chief Engineer, Leiman Bros., Inc.

a process tool

What it is, how it is measured, plus a roundup of applications and products.

There are various gages and scales for measuring and describing degrees of vacuum as indicated in Table I. Some gages have their zero set at atmospheric pressure and indicate degree of vacuum upward from that point. Examples are the mercury U–tube manometer, the single leg mercury manometer and the dial gage. These gages are affected by atmospheric pressure, therefore, the reading of the barometer should be noted for comparison, especially when working above about 27 or 28 inches mercury.

Other gages indicate zero only when there is a perfect vacuum or void. Gages of this type are the barometer, the Dubrovin gage and the absolute pressure gage. Readings on the last two are not affected by changes in the atmospheric pressure.

When specifying degrees of vacuum, it is important to mention the gage referred to. For instance, seven inches mercury on a U-tube manometer is entirely different from seven inches on an absolute pressure gage. Seven inches on an absolute pressure gage is about 23 inches on a U-tube manometer. When the gage is not mentioned, it is usually understood that the U-tube manometer is referred to.

Mercury U-Tube Manometer

This gage is shown in Fig. 1. A glass tube is bent so that it has a length of about 30 inches. The length of the tube depends upon the class of work for which it is intended. The glass tube should have a minimum inside diameter of ¼ in. otherwise capillary attraction will affect the readings. The tube is filled about half full with mercury and the level marked zero. Either leg of the U-tube may be connected to the tank or pipe line to be tested. The other leg is left open to atmosphere.

In use, a slight vacuum will cause the mercury in the connected leg to rise above the zero mark and the mercury in the other leg will fall an equal amount. Both legs of the gage should have exactly the same bore. A difference of two inches between the two levels indicates two inches of vacuum. This gage is used for vacuum up to about 29½ inches.

Single Leg Mercury Manometer

Another form of mercury gage is shown in Fig. 2 in which the mercury is contained in a large reservoir *B* and is free to rise in a glass tube when suction or vacuum is connected to point A. The degree of vacuum is read by measuring from the top of the mercury in the reservoir to the top of the mercury in the tube. Usually a permanent scale is placed back of the tube.

Barometer

This is another form of mercury tube gage as shown in Fig. 3. It consists of a straight glass tube over 30 inches long having the upper end sealed tight. It is completely filled with mercury and the lower end submerged in an open vessel of mercury. The glass tube may have a bore of any diameter but about ¼ to ½ in. is most practical. Regardless of tube length (over 30 in.) the level of the mercury in the tube will be about 29.92 in. above the level of the mercury in the open vessel.

This height of mercury remains constant as long as the atmospheric pressure is 14.7 psi. However the atmospheric pressure changes from time to time and the 29.92 in. height changes with it. At sea level, the atmospheric pressure varies from ½ in. below to ½ in. above the average. For this reason it is necessary to have a barometer on hand when using a mercury manometer for testing high degrees of vacuum of 29 inches or more. It is common practice to state the degree of vacuum with reference to the barometer. For instance 29½ in. mercury with reference to 30 in. barometer or within ½ in. of the barometer.

When working at distances above sea level the barometer will read less than 29.92 in. At 1000 feet altitude the barometer will read about 29 in. and the reading will be lower at still higher altitudes.

Dial Gages

Although mercury gages are the most accurate type, they are too fragile and inconvenient to carry in the field. For such applications the dial gage is used as shown in Fig. 4. In its simplest form this consists of a curved Bourdon tube, the end of which is connected by a rack to a pinion gear on the shaft of the pointer. When vacuum is applied to the curved tube, the tube tends to curve more and cause the end to pull on the pinion and swing the pointer.

Dubrovin Vacuum Gage

This gage is used for measuring high degrees of vacuum, in the order of one to 20 mm absolute pressure. As shown

Symbols

a — Area in sq. inches

D — Diameter in inches

F — Linear velocity in ft. per minute

I_M — Inches of mercury, gage (U-tube manometer)

P — Gage pressure in lb per sq. in.

P_A — Absolute pressure in lb per sq in.

V — Volume of free air in cu. ft.

V_e — Volume of expanded air in cu. ft.

π — 3.1416

SOME USEFUL FORMULAS

To find the volume of a given amount of air when it is under vacuum (when atmospheric pressure is 14.7 lb.).

$$V_e = V \frac{14.7}{P_A}$$

To find the velocity in feet per minute of air flowing through a pipe when the volume is known (friction not considered):

$$F = \frac{576\ V}{\pi\ D^2}$$

When air flows through an orifice and the diameter is constant, the pressure will vary as the square of the volume:

$$\frac{P}{P_1} = \frac{V^2}{V_1^2}$$

When pressure is constant, the volume will vary as the square of the diameter:

$$\frac{V}{V_1} = \frac{D^2}{D_1^2}$$

When the volume is constant,

$$\frac{P}{P_1} = \frac{D^4}{D_1^4}$$

These relationships have been calculated for many typical applications and listed in Table II.

Lifting force of a sucker operated by vacuum:

$$\text{Force (in pounds)} = \frac{I_M\ a}{2}$$

in Fig. 5 it consists of a glass tube partly filled with mercury with a hollow evacuated steel cylinder floating in it. When the outlet A is connected to the system to be measured, vacuum causes the steel cylinder to rise in proportion to the degree of vacuum. A change of one mm in the vacuum causes the cylinder to rise about nine mm so that it is easy to read.

Absolute Pressure Gage

This gage, Fig. 6, is used for reading absolute pressure and is not affected by changes in the atmospheric pressure. The end A is sealed tight and mercury completely fills this end when gage is not being used. The open end B is connected to the vacuum line and when the vacuum is high enough the mercury is pulled down from the end A. The sliding scale is positioned so that its zero is opposite the mercury level in leg B and the difference in the mercury levels in the two legs can be read on the scale which is usually graduated in inches or millimeters.

UNITS OF MEASURE

Several different units are used for measuring degrees of vacuum: inches, feet, millimeters and microns. For medium degrees of vacuum the scale is divided in inches. This scale is used on water manometers, mercury manometers, barometers and dial gages and is usually used for vacuum up to about 29 or 29½ in. mercury.

Scales divided in feet may be applied to water manometers but they are seldom used because such gages are too cumbersome to handle.

For vacuum in the range of about 29 inches to a nearly perfect vacuum a metric scale is used, divided in millimeters. This scale is used on mercury manometers, barometers, McLeod gages, dial gages and Dubrovin gages.

For extremely high vacuum in the range of one millimeter or less (absolute pressure) microns are the units of measure used. Since a micron is 1/1000 of a millimeter, it cannot be seen with the naked eye and a sensitive instrument such as a Pirani gage or a McLeod gage must be used for measurements.

TABLE II—FLOW OF AIR THROUGH ORIFICES UNDER VACUUM
Free Air, cu ft/per min, approx

Orifice Dia, in.	Inches of Vacuum on Mercury Gage									
	1/2	1	2	4	6	8	10	12	16	20
1/16	0.15	0.21	0.30	0.43	0.55	0.65	0.74	0.84	1.0	1.2
1/8	0.6	0.8	1.2	1.8	2.2	2.5	3.0	3.3	4.0	4.7
3/16	1.9	2.4	3.1	4.2	5.1	6.0	7.0	7.5	8.8	11
1/4	2.7	3.7	4.5	6.6	8.7	10	12	13	16	18
5/16	4.0	5.7	7.5	11	14	17	19	21	25	30
3/8	5.6	8	11	17	21	25	29	32	39	45
7/16	7.8	11	16	23	29	34	38	42	50	60
1/2	10	14	20	29	37	44	50	57	69	81
5/8	16	23	35	49	61	73	83	94	112	
3/4	24	34	49	72	90	107	123	139		

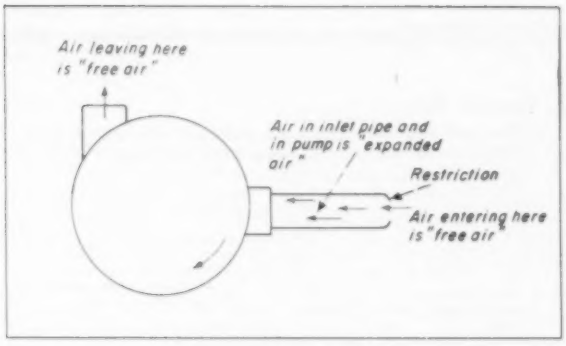


Fig. 7—Pump displacement ratings are dependent on where they are measured. Most are rated in cfm of expanded air at a given vacuum.

VACUUM PUMPS

For producing medium degrees of vacuum the rotary type pump is the most popular. It gives a steady flow of air and is small in size for the volume of air that it moves. Other types include reciprocating piston pumps, diaphragm pumps and steam injectors.

Pump Ratings

Pumps are usually rated according to their displacement. This is the actual volume of air moved inside the pump. It is the volume of air exhausted when there is no vacuum or pressure load on the pump. An inefficient pump may have a large displacement but a small capacity because of internal losses or slippage.

When a pump runs under pressure there is some internal slippage and the output capacity is less than the displacement. Sometimes, but very seldom, the output is measured while the air is still in the compressed state. This, of course, is less than the air in the free state.

When a pump runs under vacuum, the air inside the pump is in an expanded state and the output, when measured in the free state, is always less than the displacement even if the pump were 100 per cent efficient. Thus, a vacuum pump may have its capacity rated in free air output or expanded air input as shown in Fig. 7. If a pump were 100 per cent efficient the expanded air volume would equal the pump displacement. If a pump were running under 27 in. of mercury vacuum and nine cfm of free air entered the pump, the air would expand to 90 cubic feet inside the pump and would shrink back to nine cubic feet when it left the pump.

When seeking a vacuum pump, bear in mind that the less vacuum needed the lower the price of the pump. Most pumps easily pull up to 20 in. vacuum but it is more difficult to pull up to 25 to 28 in. and 29 in. is still more difficult. All vacuum pumps fall off in capacity as the vacuum goes up, so there will be more air movement at a lower vacuum than at a higher vacuum. When working at 29 inches or more, the tiniest leak in the system will make it almost impossible to maintain the vacuum unless the pump is very large. Also, the higher the vacuum the hotter the pump will get and the more difficult it will be to lubricate moving parts and bearings properly.

Reservoir Tanks

When vacuum is used intermittently, as in picking up sheets of paper, a tank can be used to store vacuum during the intervals when the vacuum is not used. If the vacuum is used only one half of the time during each cycle, the vacuum can be stored in the tank during the other half of the time. This permits using a smaller pump.

The larger the tank, the less fluctuation there will be in the vacuum. There is no set rule for determining the size of the tank but in many cases a tank about $\frac{1}{10}$ of the cfm capacity of the pump is used.

VACUUM PICK UP

In the operation of "pick off" or "pick up" by vacuum a vacuum tank is seldom required. Only when operations require a large volume of air instantaneously, with a time lag long enough to recharge the tank before the next requirement, is a tank used.

Vacuum requirement is dependent upon the type and weight of the article being held and its movement. This determines the quantity, type and size of suckers. Most articles require more than one sucker so that weight can be balanced or movement can be better controlled. The size of the sucker openings in the vacuum line determines the effectiveness with which articles are controlled. The relationship of these openings bears a direct relationship to the pump and pipe lines.

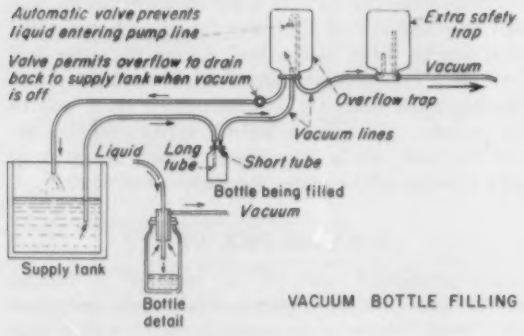
Half inch OD suckers can be used on light articles or small sheets of paper and one inch OD and up on larger pieces. The area of the sucker in square inches times the amount of vacuum in inches mercury, determines the holding or lifting power. Every inch of vacuum on every square inch of holding area exerts a half pound lifting power. This lifting power may be exerted against weight of article, static pull and shearing thrust.

In all cases vacuum should be kept to the minimum to reduce size of pump, horsepower and porosity lift. In "pick up" of paper, high vacuums will have a tendency to lift more than one sheet, through the porosity of the top sheet.

Volume of air evacuated is determined by the pipe volume between suckers and pump (or valve if one is used), plus leakage at sucker contact. The ability of a vacuum sucker to hold a sheet of paper is more dependent upon line size than upon degree of vacuum. This volume is multiplied by number of operations per minute and compared to tables showing volume produced by various sized pumps, at the degree of vacuum used, to chose a properly sized pump.

Where valves are used in the vacuum line they should be placed as close to the suckers as possible and the lines from the suckers to the valve should be as small as possible without causing flow constriction (such as elbows and tees). For one inch suckers, $\frac{1}{4}$ in. ID vacuum hose is usually satisfactory. The line from the valve to the pump should be of good size to act as vacuum storage space built up when the valve is closed. When the valve opens, this ready-made vacuum, occupying the greater portion of the line helps furnish the snap for fast operation so necessary at high speeds.

A brief review of medium pressure applications appears on the next two pages.



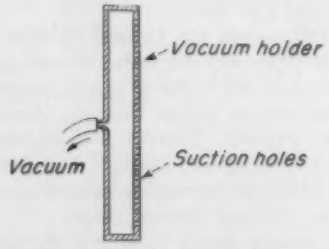
VACUUM BOTTLE FILLING

Bottle Filling

Bottles can be rapidly filled with liquid to a uniform height by sucking the air out of the bottles with one tube while another tube lets the liquid rush in.

Boiling Water, etc. Without Heat

Since the boiling point of water and other liquids is lowered considerably when placed in a vacuum, water and aqueous liquids can be made to boil and evaporate at low temperatures so as not to affect the flavor. Evaporated milk is one example.



VACUUM CAMERA BACK OR COPY HOLDER BOARD

Camera Back

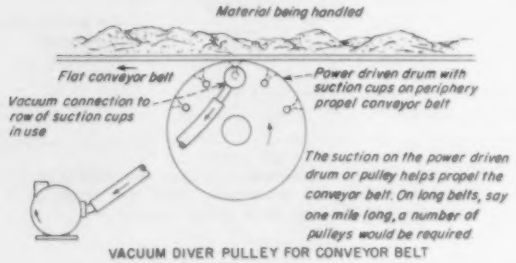
Large sheets of thin photo film can be held flat in the camera by placing it on a flat plate drilled with many small holes connected to a vacuum pump.

Chucking

Thin, irregularly shaped pieces which cannot be held in a mechanical chuck can be held in a vacuum chuck which is shaped to fit the work piece and which has a number of suction holes in it. Master phonograph records are held this way. Cooking pots are held while being polished.

Conveyor Belt

For conveying sheets of paper, conveyor belts are sometimes made with suction holes to hold down the paper.


Material being handled
Flat conveyor belt
Power driven drum with suction cups on periphery propel conveyor belt
Vacuum connection to row of suction cups in use
The suction on the power driven drum or pulley helps propel the conveyor belt. On long belts, say one mile long, a number of pulleys would be required

VACUUM DIVER PULLEY FOR CONVEYOR BELT

Cooker, Vacuum

Some materials which would be harmed by the high temperature ordinarily used to boil or cook them, are placed in a vacuum pan so that they can be cooked at a low temperature.

De-Aerating

Some viscous materials must not have any air bubbles in them when they are put to use so they are mixed and processed in a vacuum chamber. Moulded ceramics is an example.

Dehydrating

Water is removed from some materials by placing them in a vacuum chamber where the high vacuum causes the water to boil off at room temperature. Fruits are dried in this manner.

Dust Sampling

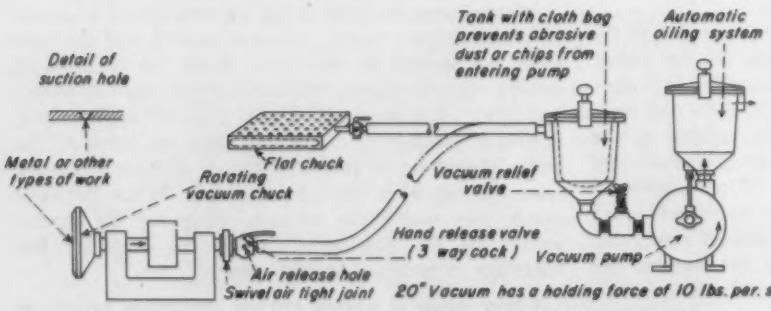
In workrooms where dust is a hazard, samples of the air are sucked into and through a jar containing water. After a measured amount of air has been sucked through, the water is placed under a microscope and the particles of dust are counted.

Freeze Drying

Liquids while in the frozen state will become more concentrated and finally dry up if placed in a vacuum chamber. This is called sublimation. Examples are, frozen orange juice and blood plasma.

Filling Ampules

Small vials, ampules and thermometers can be quickly filled by submerging them in the liquid and then pulling a high vacuum on the vat. The vacuum pulls the air out of the ampule and when released, the liquid flows in.


Tank with cloth bag prevents abrasive dust or chips from entering pump
Automatic oiling system
Detail of suction hole
Metal or other types of work
Flat chuck
Rotating Vacuum chuck
Vacuum relief valve
Hand release valve (3 way cock)
Vacuum pump
Air release hole
Swivel air tight joint
20" Vacuum has a holding force of 10 lbs. per. sq. in. of work surface

Size of pump	Diam. of work	Kind of oper.	Vac.
26	2"	Light grinding or buffing	20"
A	3"		20"
B	6"		20"
C	10"		20"
28-3	6"	Heavy grinding light turning	28"
29-3	8"		28"
29-6	10"		28"

VACUUM CHUCKING AND HOLDING

Filtering

Filtering is speeded up when suction is used to pull the liquid through the filter material.

Heating System

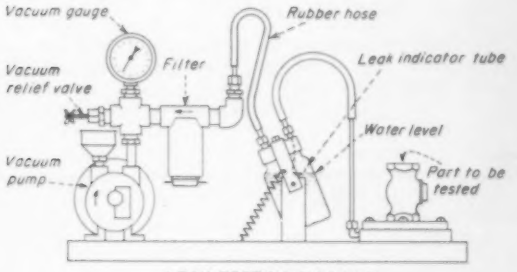
Many steam heating systems depend upon vacuum for better operation. A vacuum line connection to each radiator rapidly sucks the cold air out of the radiator, causing it to get hot rapidly. By holding a slight vacuum on the whole system, steam is generated at a temperature below the ordinary boiling point of 212 degrees.

Instrument Testing

Aeroplane instruments which normally operate on vacuum while up in the air, can be tested in the laboratory by connecting them to a vacuum line. Altimeters can be checked in the laboratory by connecting them to a vacuum pump and varying the vacuum to correspond with the vacuum found at various altitudes.

Iron Lung

Vacuum alternating with pressure is used to keep patients alive in the iron lung. The vacuum periods are timed to correspond with the normal respiratory periods.



LEAK TESTING MACHINE

Leak Testing

Production testing of valves and similar castings can be tested for leaks by placing them, one by one, over an inlet to a vacuum line. A jar in the vacuum line, partly filled with water shows bubbles when there is a leak.

Lifting

Heavy pieces which cannot be easily lifted by mechanical means, can be lifted by vacuum suckers. A lifting force of 10 to 14 pounds per square inch of sucker area can be obtained.

Liquid Extracting

In some textile processes, wet cloth is passed over a hollow suction bar having a slot in it where the water is sucked from the cloth.

Lifting Liquids

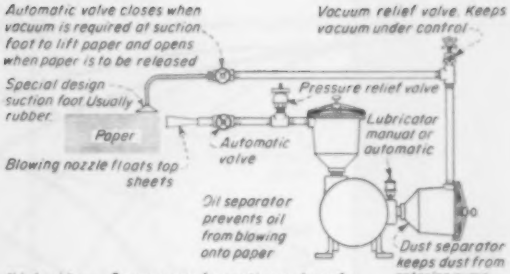
Corrosive liquids and acids which are difficult to handle with liquid pumps, can be transferred from one container to another by applying vacuum to the second container and sucking the liquid into it.

Oil Wells

Oil wells in which the oil has stopped flowing from the surrounding strata into the well sump, can be made to produce again by applying a vacuum to the well casing so as to suck the oil into the sump.

Paper Moulding

Various shapes can be made from paper pulp by submerging a hollow porous mould in a vat of paper pulp. A vacuum connection to the hollow mould draws the pulp to the mould until a proper thickness of pulp has collected on it.


Automatic valve closes when vacuum is required at suction foot to lift paper and opens when paper is to be released
Vacuum relief valve. Keeps vacuum under control
Special design suction foot Usually rubber.
Pressure relief valve
Lubricator manual or automatic
Paper
Automatic valve
Blowing nozzle floats top sheets
Oil separator prevents oil from blowing onto paper
Dust separator keeps dust from entering pump
It is best to use 2 pumps, one for suction and one for blowing. About 12 to 15 inches vacuum and 5 pounds pressure is required.

PAPER AND SHEET FEEDER

Paper Sheet Feeding

Sheets of paper can be picked up one by one from a pile by use of vacuum suckers and fed into printing presses and other machines.

Paper Tubes

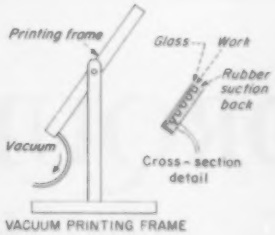
These are made by sucking the leading edge of a sheet of paper against the vacuum slot in a hollow mandrel and then winding the paper on the rotating mandrel.

Preventing Bubbles

When pouring molten metal into moulds, air bubbles in the metal can be prevented by carrying on the process in a vacuum chamber. When making moulds with the wet plaster, air bubbles can be eliminated in the same manner.

Priming Water Pumps

Centrifugal water pumps will not pump until they are filled with water. This can easily be accomplished by connecting a vacuum line to a point at the top of the pump casing. This causes the water to rise in the lift pipe and fill the pump.



VACUUM PRINTING FRAME

Printing Frame

A good tight contact is necessary when making photo offset plates from the original negative and this is accomplished by sucking the plate tight against the negative in a vacuum printing frame.

Stereotype Casting

When casting curved stereotype plates for cylinder type printing presses the flexible asbestos matrix is held against one side of the curved casting mould by vacuum while the metal is poured.

Sump Cleaning

Sumps and cesspools can be cleaned out by inserting a suction hose to the bottom. A separator tank in the vacuum line traps the liquid and allows the air to pass to the vacuum pump.

Surgical Operating

When performing surgical operations it is very convenient to suck away the drainage. A glass jar is usually set in the vacuum line to trap and separate the drainage from the air.

Vacuum Cleaning

Most everyone is familiar with this process whereby dust and dirt is sucked into the filter bag from the floor by means of vacuum.

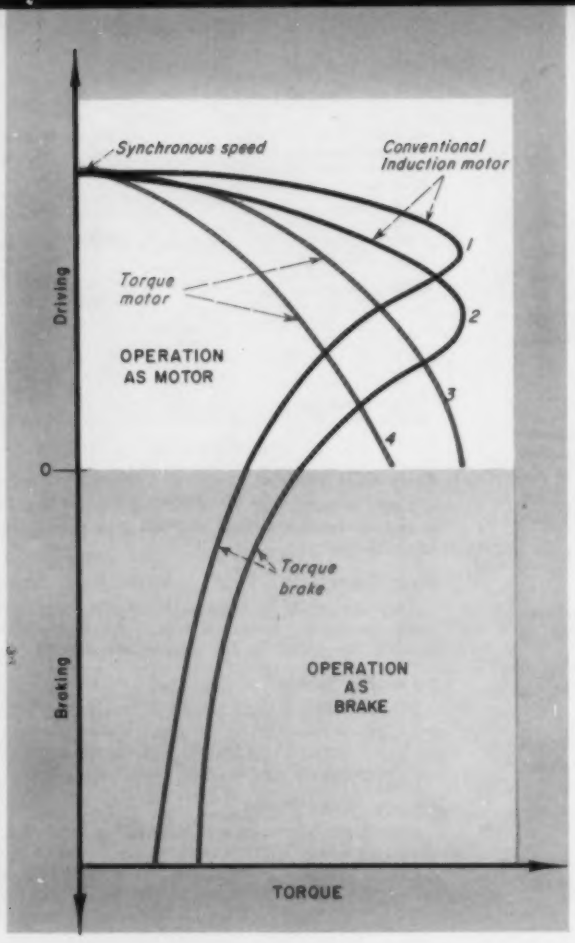


Fig. 1—Speed-torque characteristics of standard polyphase induction motors, torque motors, and torque brakes. Curves in upper half of graph are for motor operation in which rotation of motor shaft is in same direction as the internal rotating magnetic field of the motor. In this section, curves 1 and 2 are typical of standard polyphase motors; curves 3 and 4 are typical of torque motors. Stall torque is increased and locked-rotor current reduced for these units. In lower half, curves 1 and 2 are typical of torque brakes; shaft rotation in these units is backwards, or in a direction opposite the internal rotating field. In winding and similar applications, brake torque is in the same direction as load torque, and both are opposite driving-motor torque.

TORQUE MOTORS and

. . . what they can do . . . and where

Drives requiring limited, stalled, or backward rotation in braking, clamping, indexing, traversing, or braking tension control are typical applications. Here also are speed-torque characteristics, ratings, frame sizes, and variable-voltage controls.

Torque motors and torque brakes are special designs of polyphase induction motors. Basic differences between torque units and induction motors lie in torque-speed characteristics, the ability to withstand locked-rotor currents, and the type of application. Torque motors are usually identified by a nameplate which carries a torque instead of a horsepower rating. They are used where the rotor turns for some part of the duty cycle, then is stalled for another portion. As a result, physical construction is modified to permit locked-rotor currents for varying periods of time, and the speed-torque curves of these devices are modified to decrease locked-rotor current and increase locked-rotor torque, Fig. 1.

Here, the characteristic curves of induction motors are indicated in the upper half of the figure by curves *1* and 2, while curves 3 and *4* are representative of torque-motor characteristics. When these torque devices are operated as motors, rotation of the polyphase magnetic field is in the same direction as the motor rotor, and is indicated in Fig. 1 by the positive (driving) direction of rotation. The rotors of torque brakes apply torque opposing the load rotation, and as a result the rotation of the brake unit magnetic field is in a direction opposite shaft rotation; this is indicated by negative (braking) rotation.

Torque Motor Applications

One of the severest duty-cycle applications is that in which the motor is stalled 100% of the time. This

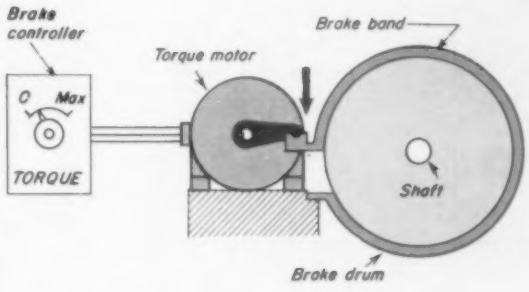


Fig. 2—Torque motor used to tighten friction band on brake drum. Controller supplies variable voltage which controls degree of braking. Here torque motor operates in a continuous-stalled condition.

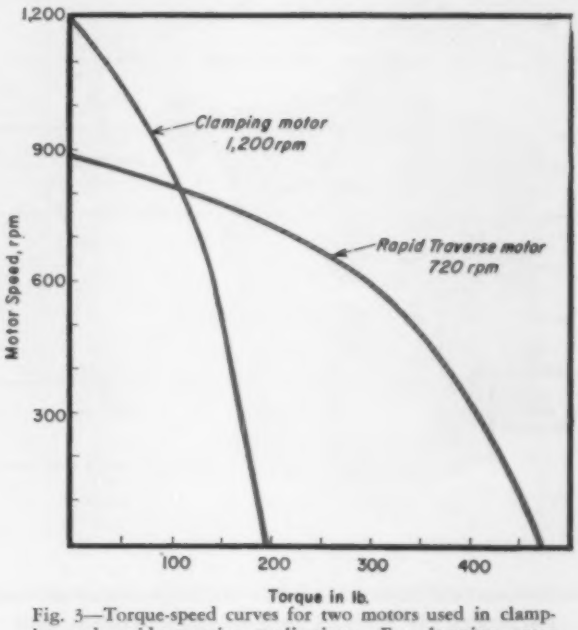


Fig. 3—Torque-speed curves for two motors used in clamping and rapid-traversing applications. For clamping, rotor speed and inertia are maintained at a minimum. Torque required to unclamp is usually higher than that for clamping. Rapid-traverse motor indicated is rated at full-load rpm of 720, although synchronous speed is 900 rpm.

BRAKES

S. NOODLEMAN
Vice-president, B. A. Wesche Electric Company

occurs in braking operations, Fig. 2. Here motor torque serves to tighten the friction band, controlling the degree of braking. Use of a variable-voltage supply from the controller permits a wide range of torque control. The majority of applications, which are less severe, fall in the following categories:

Clamping

Speed-torque characteristic of a torque motor used for a typical clamping operation is shown in Fig. 3. Here, the rotor moves one-half to two-thirds of a revolution and applies torque to a cam which performs the clamping function. The torque required to clamp is usually less than the unclamping torque. For this reason, it is desirable to reduce rotational inertia to a minimum. This is accomplished by keeping both system inertia and rotor speed as low as possible.

Use of low rotor speeds increases motor heating. However, in clamping operations, the motor is energized for only a short portion of the cycle and motors of low speed can be safely used. For example, synchronous speeds of 900 rpm can be obtained for motors 4 in. in diameter, 600 rpm for 5¾-in. motors, 450 rpm for 6¾-in. motors and 300 rpm for 8⅝-in. motors. Torque is usually provided until the clamping action is completed after which the motor is deenergized. As a result a smaller, less expensive motor can be used. For this requirement, timers or limit switches, Fig. 4, are used to remove power. In the two typical systems for clamp control shown, the CLAMP and UNCLAMP relays are mechanically interlocked to prevent damage to motor or machine.

Valve or Screw Operation

The same general motor characteristics used for clamping functions are used in tightening valves or screws, in which case the motor operates at some speed for a short time, then slows down and stalls, maintaining torque on the screw device.

While rotational energy is not necessarily limited to a minimum in this type of application, it must be controlled to prevent sudden shock, jarring, or even snapping of the rotor shaft when the rotor is abruptly stopped at the end of valve or screw travel. Torque motors designed for continuous stalled operation may be used, but a smaller motor can be specified if the power is removed from the motor after it has reached a stalled condition, as in the clamping applications.

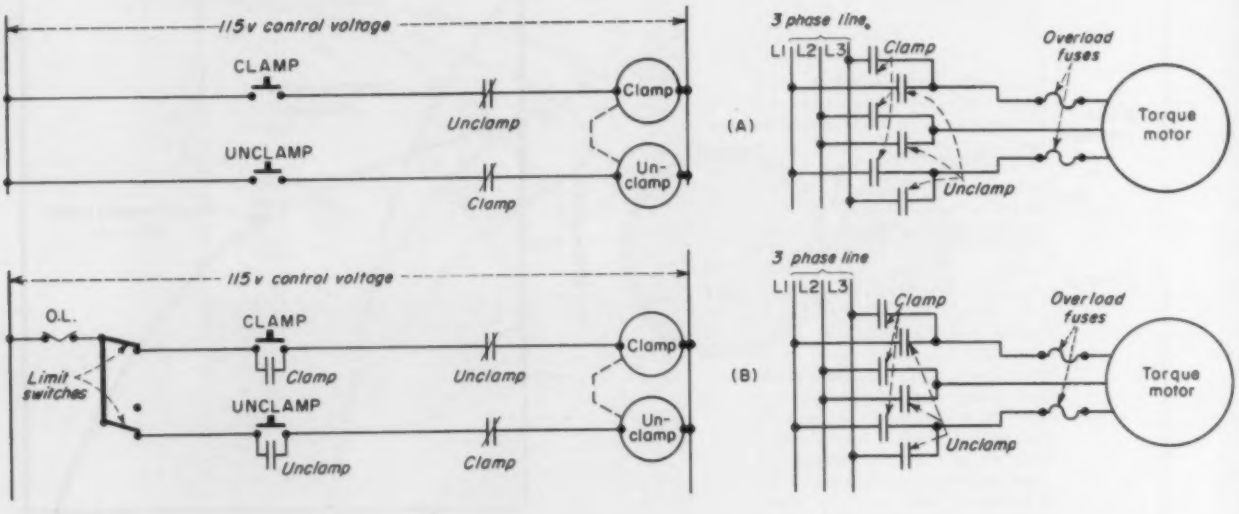


Fig. 4—Two basic control circuits for torque motors in clamping applications. (A) is simple basic circuit. CLAMP and UNCLAMP relays are mechanically interlocked. (B) To avoid use of expensive continuous-duty torque motor, CLAMP and UNCLAMP limit switches are included in this circuit. When clamping or unclamping action is completed, power is removed from the motor; this allows use of a smaller motor. Timers are also used for the same function.

Indexing and Rapid Traversing

Applications which require extended rapid movement, such as automatic indexing of a fixture or automatic positioning of machine parts, require motors which are energized a substantially longer period of the duty cycle than in the previous clamping and valve applications.

Rapid-Traverse Applications

Here the motor is commonly operated at one-half synchronous rpm or somewhat higher. As a result, rapid-traverse motors require a speed-torque characteristic with less slip than provided for stalled or clamping motors; typical characteristics are shown by curves 2 or 3 in the upper half of Fig. 1.

Torque motors are normally rated by their stalled torque and stalled current but for rapid-traverse applications, or whenever a motor is developing power instead of stalled torque, the motor nameplate rating may be in horsepower at the approximate speed required for the application. This permits proper selection of overload relay heaters and provides better protection for the motor under its actual operating conditions. However, nameplates rated this way usually show an odd horsepower and speed relation compared to the data usually shown on standard motors; the speed rating may not bear any relation to the motor synchronous speed. For example, the rapid-traverse motor indicated in Fig. 3 is rated at 2.5 hp and 720 rpm. Synchronous speed of this motor is actually 900 rpm, but under the given load condition it operates at 720 rpm. For this type operation the motor is therefore operated between the totally stalled condition and the constant-running condition, hence smaller required slip.

Winding Applications

While previous applications have used motors as required for power and stall torque, winding applications require that the motor operates at a continually changing speed determined by the varying load conditions of the application. Thus, a motor may operate from stalled to almost synchronous speed. Winding operations requiring constant speed and tension of the wire or other material being wound must have motors with speed-torque characteristics which provide the correct changing torque as determined by the changing diameter of the winding reel.

Tension for controlling the supply wheel may be adjusted by use of a mechanical tension device or by a magnetic brake such as a torque-brake unit. The torque motor driving the reel then automatically winds the material at a speed determined by this tension and the reel diameter. As the diameter of the material builds up, the motor automatically slows down to maintain a constant material speed. Fig. 5 illustrates an arrangement using this principle.

While in the previous applications the torque motors are generally rated for intermittent or short-time operations, for winding applications they are usually rated 50% continuous or continuous-stalled duty. Fifty-percent duty indicates that the motor may be stalled for 50% of the time, and usually for a specified maximum time limit. Continuous-duty motors can be stalled indefinitely at rated voltage without exceeding rated temperature rise.

In intermittent-duty rating, stalled torque for a given frame is generally high and in most cases is greater than

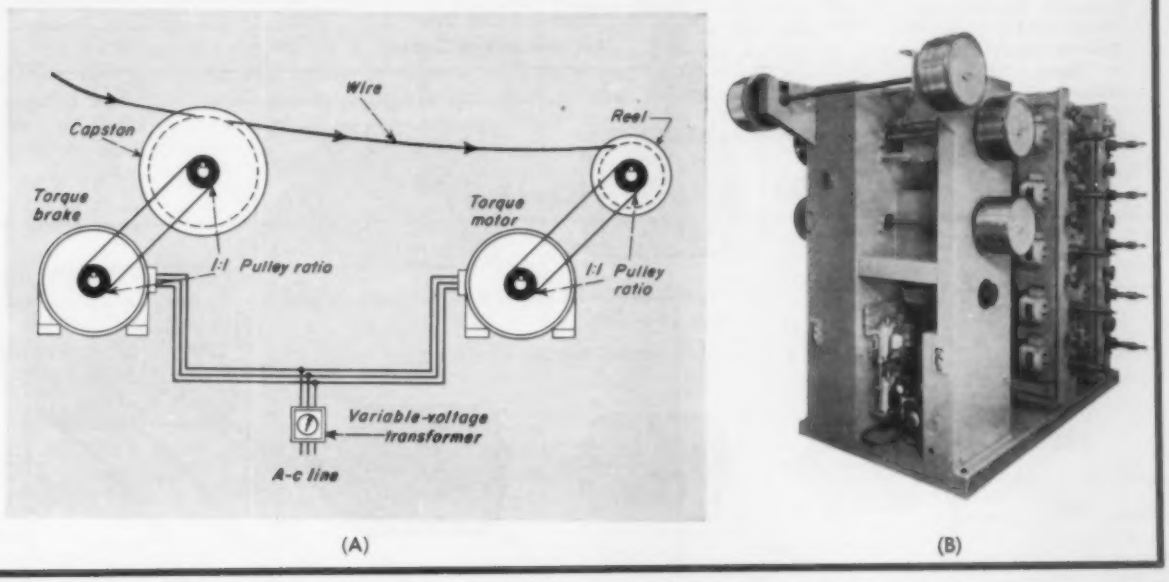


Fig. 5—(A) Torque-motor and torque-brake combination for winding wire on reel. Tension against wire on reel is applied by the torque brake. Torque motor drives wire at a speed dependent on tension of torque brake and instantaneous reel diameter. As reel diameter increases, speed of torque motor is automatically reduced and torque increased. (B) Twenty wires from an enameling oven are wound on 20 reels (not shown) on this machine by American Insulating Machinery Co. A separate take-up motor is used for each reel. A variable-voltage control, adjusts motor torque to obtain proper wire tension.

that provided by standard motors. For motors of continuous-stalled ratings, the reverse is true. For example, a motor of this type rated 60 in.-lb. is designed in a NEMA 284 frame, whereas a standard motor in this frame provides stalled torques of 600 in.-lb. for the same synchronous speed. For a motor with a continuous-stalled rating, the torque is low in relation to its frame size, therefore bearing friction and windage, which normally represent a small part of the standard motor load, become increasingly important.

As a result, when a continuous-duty torque motor is required to maintain a constant speed over a wide range of torques, the no-load speed at reduced torques becomes progressively lower than synchronous. While at rated voltage, desired top speed and torque may be satisfactory, at reduced voltage motor friction changes the shape of the speed-torque curves, as shown at (A) in Fig. 6 for a continuous-duty motor. The no-load speeds at reduced torques are limited by motor friction alone.

The percentage of time which the torque motor is operated at the stalled condition, as well as synchronous speed of the motor materially affect the frame size. This is shown in Table I which gives approximate frame sizes for torque motors of 48 in.-lb ratings and synchronous speeds of 600, 900, and 1200 rpm.

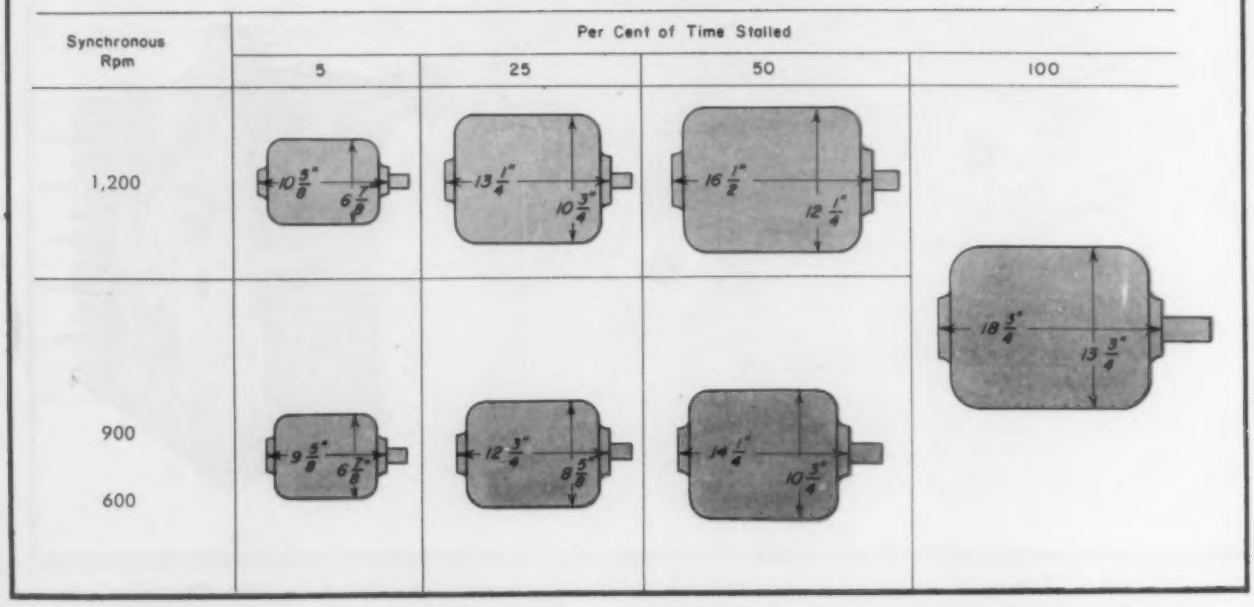
Torque Brakes

To obtain braking torque in a motor, the rotor is driven in a direction opposite its driving magnetic field. In the brake (lower) area of Fig. 1, curve 1 shows the speed-torque characteristic usually required for winding applications which use the torque brake or backward-driven motor. These units provide the tension drag needed in many winding operations. In winding machines it is desirable to match the speed-torque characteristic of the brake to the changing load in order to obtain constant winding tension. However, it is usually more difficult to obtain the most desirable speed-torque characteristics for torque-brake units than for torque motors.

In both continuous-stalled-duty torque motors and torque brakes, the limiting factor which determines frame size is not the torque which can be produced, but the heat and temperature rise developed at the torque rating. Consequently, torque motors have a low torque rating for the frame size when compared with standard motors, and torque brakes of the continuous-stalled type have an even lower torque for a given frame. This is because the most suitable speed-torque characteristic for constant-tension brake control requires a rotor of low resistance, which provides less than maximum stalled torque per input watt; consequently more surface area or frame is required to maintain temperature within rating limits. With torque motors the high-resistance rotor inherently provides maximum stalled torque per input watt. However, to dissipate the additional heat, rotors of special designs are used.

Forced Ventilation

It is often desired to obtain greater torque than possible with the usual frame. One method is to provide external cooling by combining the torque unit with a blower; this permits a reduction in motor-frame size. However, when using a motor with forced ventilation the blower must always be rotating in the direction to force air through the motor. For blowers operating on single phase this



operates on reversing duty, 3-phase blower motors must be connected so as to maintain proper blower rotation.

Variable Voltage Control

The usual method of controlling torque units is to provide variable polyphase voltages. Two methods of obtaining the variable 3-phase voltage area shown at (A) in Fig. 6. For torque units of the continuous stalled duty or 50% stalled duty, with these connections, the torque at any speed varies as the square of the applied voltage. For a 220-volt, 3-phase supply, single-phase variable transformers of 120 volts may be used connected in wye as shown at top. For the same input voltage, variable transformers of 220-volt rating can be connected in open delta as indicated at bottom. For other voltage ratings, cost usually dictates whether wye or open delta is more suitable.

Another method of control, shown in (*B*), is simpler to operate and of lower cost; this system provides variable voltage transformer is applied across one phase of the 3-phase supply and connected to the torque-motor or brake terminals as shown at the right in the electrical diagram. For this type of control, torque at any speed varies directly with the ratio of the variable-phase voltage to the line voltage. For continuous stalled duty, or 50% stalled duty, and where energizing one set of windings at rated voltage will not cause overheating of the motor, use of this type of control reduces control size and cost. A typical family of speed-torque characteristics obtained from this type of control is also shown in (*B*).

Applying Torque Motors

The application of torque motors requires consideration not only of the torque, horsepower and speed determined by the application, but also of the inertia in the system, the rate of acceleration or deceleration required, and in some cases whether the shaft and rotor assembly can perform without mechanical failure because of the start, stop and jar of the shock loads. When torque units are applied, the following should be considered:

1. What is the duty cycle? How much of the time is winding energized and deenergized? Is the motor reversed; if so, how often? How often is the motor started? Does it coast to a stop, is it braked, or is it plug-stopped? What is the over-all system inertia; does it change during any part of the operating cycle?

2. What are the friction loads?

3. Can an open motor construction be used? What are the ambient conditions and factors such as coolant or oil spray which may affect life of windings or bearings?

4. How will this motor be controlled?

5. Will motor be driven backward—in a direction opposite rotation of the magnetic field (overhauling load); time involved for this condition?

6. What mechanical features are required, such as mounting, shaft size and length, conduit-box size and location?

Machine Tool Applications

The majority of machine tool applications use torque motors for the clamping, rapid traversing, and indexing functions previously described. For example, a boring mill has used a torque motor to clamp the rail to the housing. In addition rapid traverse motors are used to traverse either the ram or the saddle, or both. Automatic selection of feeds for drives can be accomplished using torque motors to operate the gear trains. Other torque motors can be used to operate the tool turrets

or the sidehead tool blocks on these machines.

Controls for these motors can be placed in a position dependent the frequency of operation and required operator accessibility, or in the case of automatic return or indexing they can be operated by the use of cams or dogs operating limit switches. Provisions for adjustment of the actuating device must be included to permit proper timing of the machine cycle.

RECOMMENDED READING: Previous articles dealing with selection and application of motors for machine-tool drives are: "Controlling Temperature Rise in Squirrel-Cage Induction Motors", January, 1957, page 167. Conventional NEMA motors and axial air-gap motors are compared in "Axial Air-Gap Motors for Machine-Tool Drives", September, 1955, page 129. A detailed analysis of NEMA Design B, C, and torque and speed ratings appears in "The Importance of Duty Cycle in Selecting Polyphase Induction Motors," November, 1954, page 174.

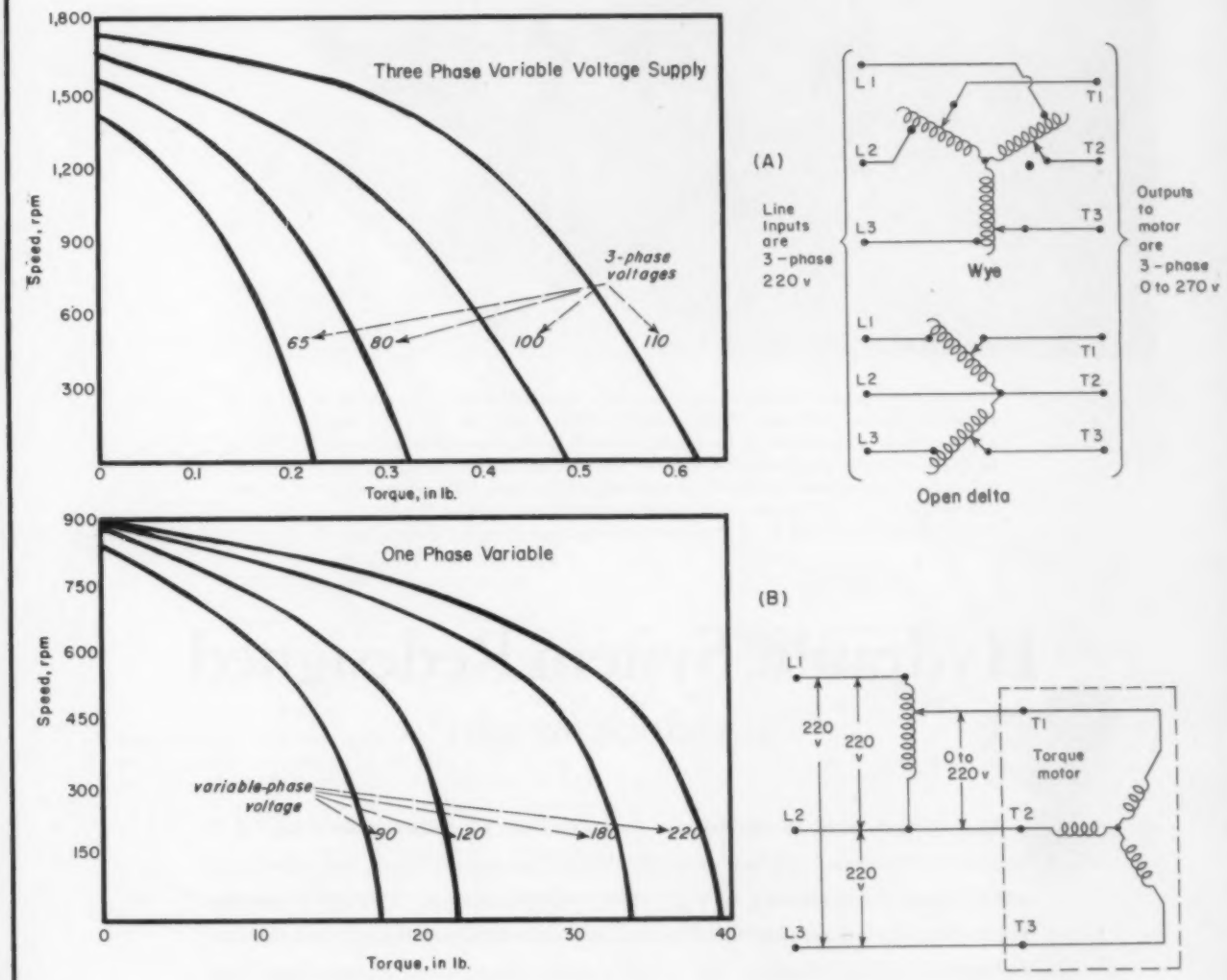
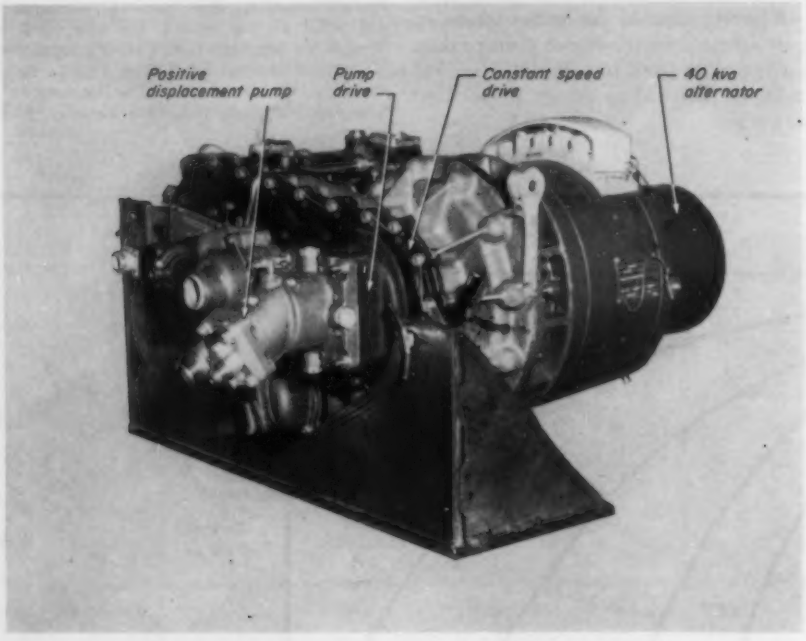


Fig. 6—(A) Connections and variation of speed and torque with voltage for a small torque motor using a 3-phase variable-voltage supply; with this type of control the motor torque varies as the square of applied voltage. (B) Connections and variation of speed and torque of a larger motor using a variable voltage from one phase of line; here, torque varies directly with the ratio of the varied voltage to line voltage. This method is simplest and most economical.

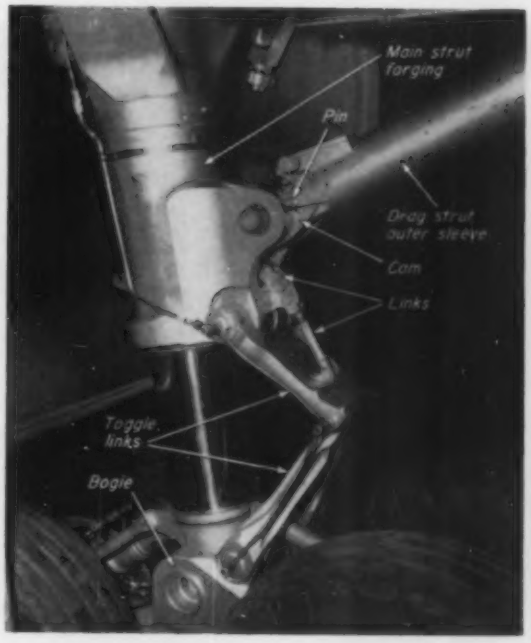


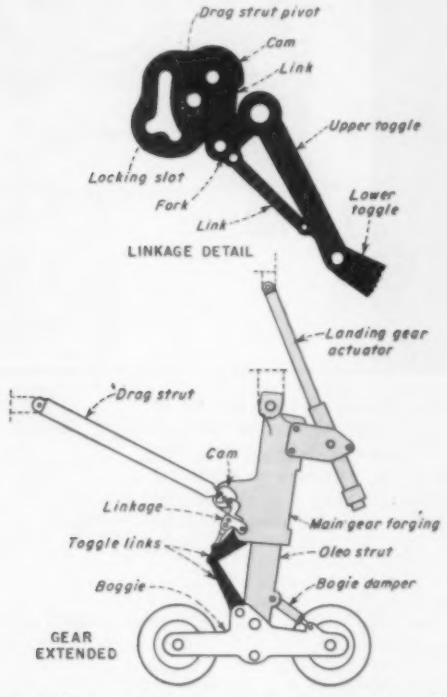
Hydraulic system for Canadian airliner has pumps mounted on the inner engine nacelle drives for two of the four 6000 rpm, 40 kva generators which supply the 400 cycle electrical system. These generators are driven by the engines through constant speed hydraulic drives. Adding 6000 to 3300 rpm speed reduction units to the generator drives allow two pumps to supply full volume requirements of the CL-28 main hydraulic system. Each pump weighs 6.7 lb. and delivers 815 gpm at 3300 rpm. Total weight increase from replacing the 4000 psi system with a 3000 psi system was 21 lb. Britannia system used four pumps, each weighing 27 lb.

Hydraulic System Redesigned
to reduce weight

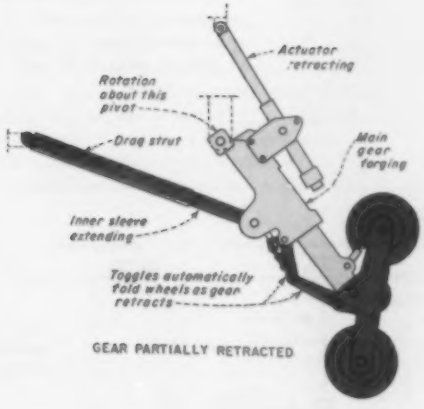
One decision faced by engineers at Canadair Ltd., when they evolved the CL-28 marine reconnaissance airplane from the Bristol Britannia airliner, was whether or not to retain the Britannia's 4000 psi utility hydraulic system. This system operates the landing gear, main gear wheel brakes, nose-wheel steering linkage, and the control surface locking cylinders. The CL-28's utility system has to perform these functions and operate bomb doors as well. A 3000 psi system pressure was finally selected as availability of qualified component suppliers was considered more important than the weight increase involved. The decision was made to recover much of the weight penalty by reviewing the design of each system element. This was accomplished with changes in the pump drive, main landing gear bogie folding mechanism, nose wheel steering and wheel braking systems.

Main landing gear bogie rotation mechanism was re-▶ designed for simplification and to reduce weight. Each main landing gear has a four-wheel bogie with an oleo-pneumatic shock strut, and a drag strut with a hydraulically released down lock. The bogie is folded through a 60 deg angle to clear compartment walls when the landing gear is retracted. On the Britannia, the bogie is folded by a hydraulic cylinder anchored on the main strut, and a sequence valve was used to program this cylinder with reference to downlock release and retraction operations. Replacing cylinder, sequence valve and associated piping with a mechanical linkage resulted in a 12 lb weight reduction in each landing gear.



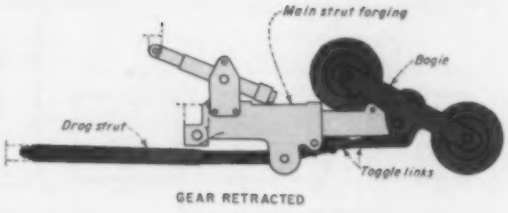


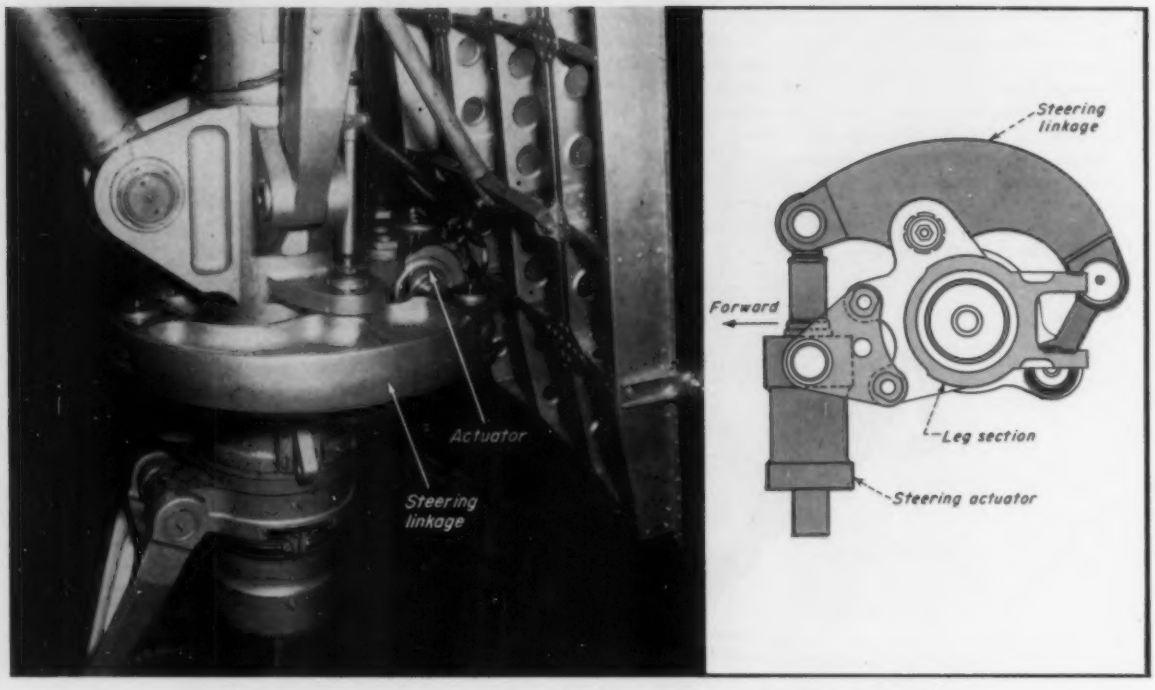
Bogie folding mechanism operates on change in relative angular position of drag strut and main strut forging as the gear retracts. Bogie carriage is connected to the main strut forging by toggle links which, in turn, are connected through short links to a cam. The cam is a yoke mounted at the lower pivot of the drag strut on the main strut forging. Hollow drag strut contains a spring loaded rod with a pin through its lower end which rides in slots in the cam.



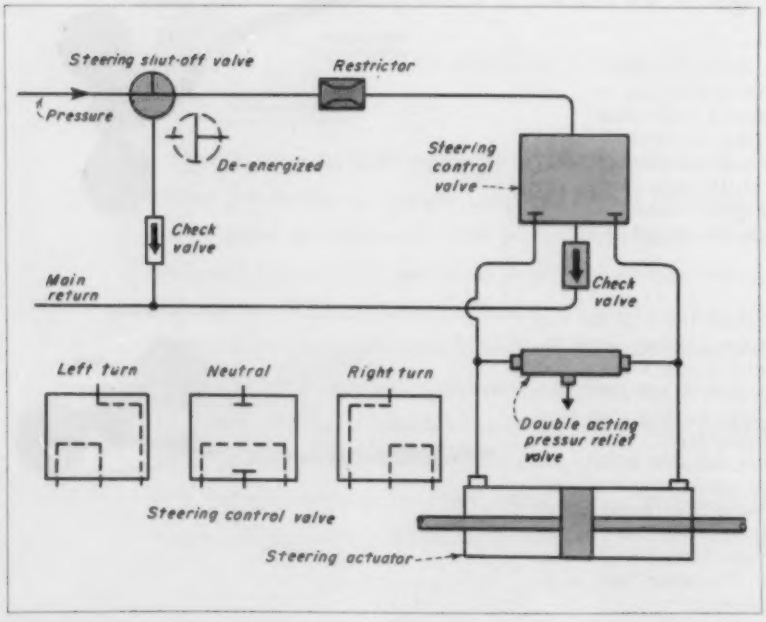
When the gear is extended, an outer sleeve on the drag strut prevents the pin from entering a locking slot in the cam, which would prevent relative motion between drag strut and cam. This pin moves freely in the radial slot, allowing cam to rotate as toggle links change position when main strut compresses under landing loads.

Spring-loaded pin enters locking slot after landing gear is retracted 2 deg, as this motion extends drag strut inner sleeve sufficiently to stop outer sleeve from bearing against the pin. Pin locks cam to drag strut and causes further gear retraction to drive the toggle links through short links connecting them to cam. This action folds bogie against main strut as the gear is stowed.



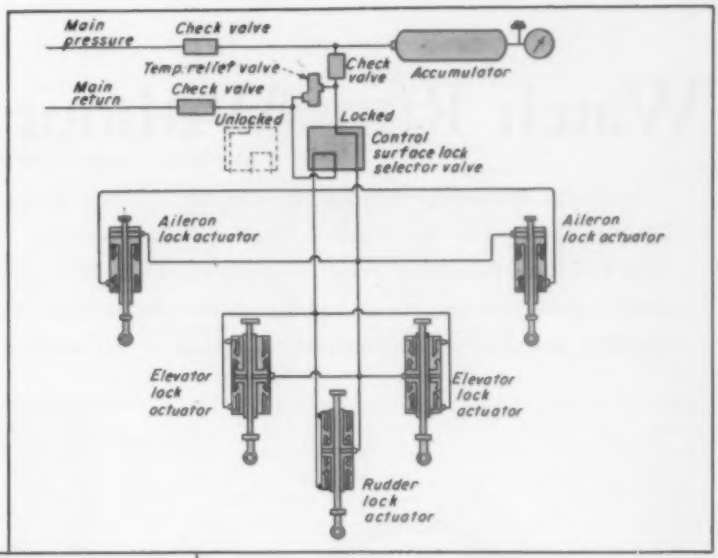


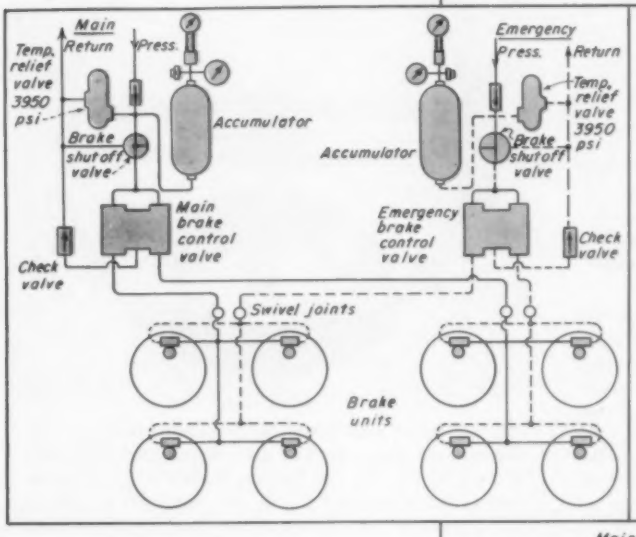
Nose wheel steering system of the Britannia used a pressure reducing valve in the hydraulic fluid supply line to reduce 4000 psi main system pressure to 2000 psi. This was done to produce smooth steering characteristics. Experience with 3000 psi steering systems now in service was the basis for a decision to delete the reducing valve and get required steering actuator force by using a cylinder reduced in area by ratio of 3 to 2. This change resulted in a weight saving of 9.6 lb.



Steering is done with a conventional wheel control linked by a torque tube-universal joint combination to the steering slide valve, which is on forward bulkhead of nose-wheel well. Follow-up control is obtained with a cable from the top of the nose-strut. No shimmey damper is used in this design, and a double-acting pressure relief valve is installed across the cylinder feed lines to handle any sudden side loads exerted on the gear. Circuit includes a solenoid operated shut-off valve, opened by nose-gear weight switch. This arrangement prevents inadvertent in-flight operation of the steering system.

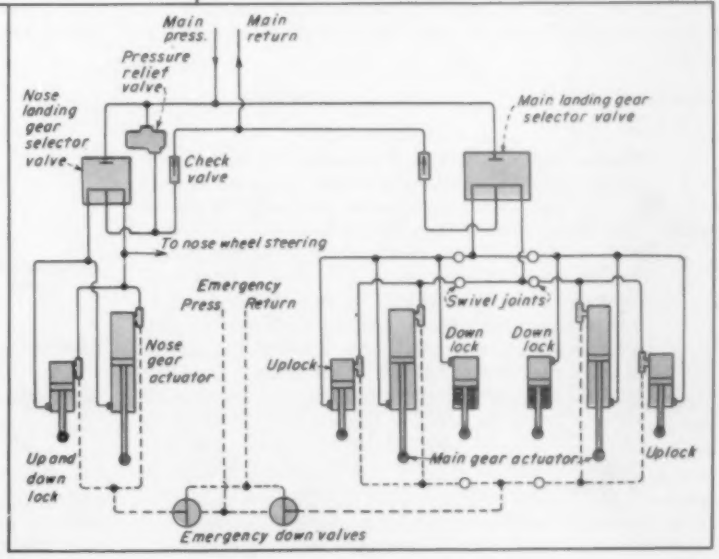
Control surface locking system has a 50 cu in. piston type accumulator, check-valved from the main system, and a manually operated four-way valve with thermal relief-valve protection. An interlock mechanism prevents developing more than 50 per cent power on any two engines if controls are locked. Collet type mechanical locks, independent of hydraulic pressure in the locked position, are used on all actuators. They are released hydraulically. Ailerons are spring-loaded in the "down" position and are locked in the "up" position by the hydraulic cylinders. When released, the springs pull them to "down" position, checking full travel freedom.





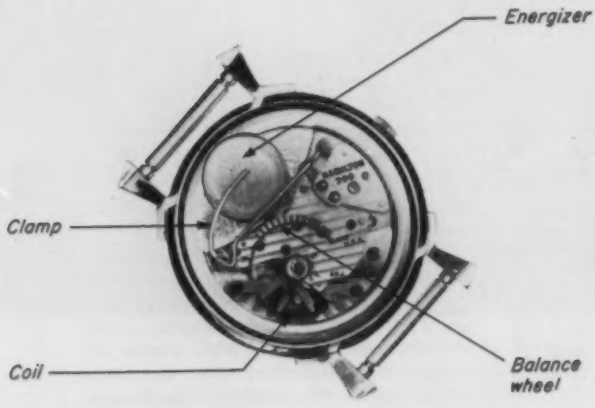
Wheel braking system on the CL-28 includes many modifications of the Britannia system. The Britannia brake uses a dual-piston design supplied with fluid from both main and emergency systems for normal braking. Failure of either system lets the remaining system continue braking action. Both systems are supplied from a common valve. For battle damage reasons, the CL-28 has separate main and emergency brake valves, operated by similar linkage systems. Emergency brake supply is shut off from the control valve when not in use by a solenoid-operated valve. When emergency system is switched on, this valve opens, and a similar valve in the main system closes. An emergency system pump then supplies fluid for full braking action.

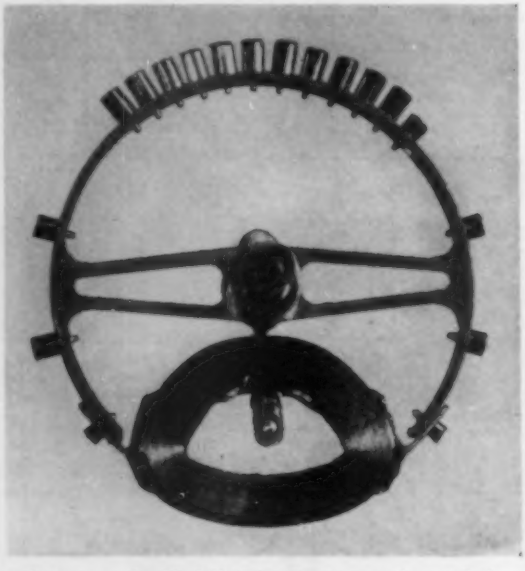
Landing gear circuit indicates simplification obtained by deleting bogie folding cylinders and sequence valves. Separate solenoid-operated four-way valves are installed at rear wing spar and in nose-wheel well for main and nose landing gears to reduce piping. Both valves are accessible in flight and have manual over-ride control for use during electrical failures. Emergency system shut-off valves are similarly positioned, and have manual over-ride controls. Main gear down-lock, built into the drag strut, is engaged mechanically on gear extension, and released hydraulically on gear retraction. In the nose gear, a single lock-cylinder performs up-lock and down-release actions.



Watch Runs Without Winding

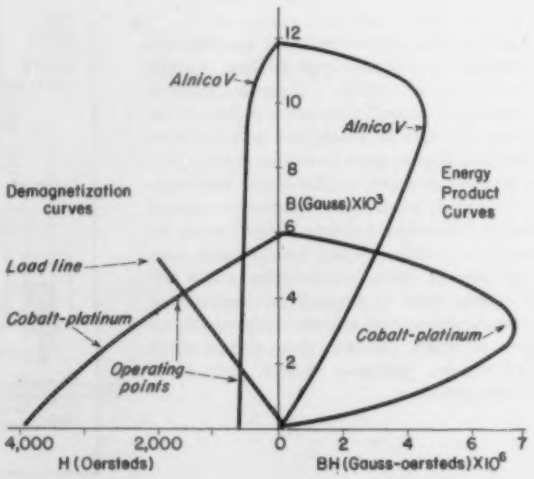
An electric wristwatch which has no mainspring and runs without winding whether or not it is worn has been developed by the Hamilton Watch Co., Lancaster, Pa. Designed under the direction of Dr. John Van Horn, Director of Research and Development, this watch incorporates the first basic change in watch construction since the mainspring was invented in 1480. Balance wheel is made to oscillate with impulses produced by intermittently energizing a coil on its rim which moves in a magnetic field.

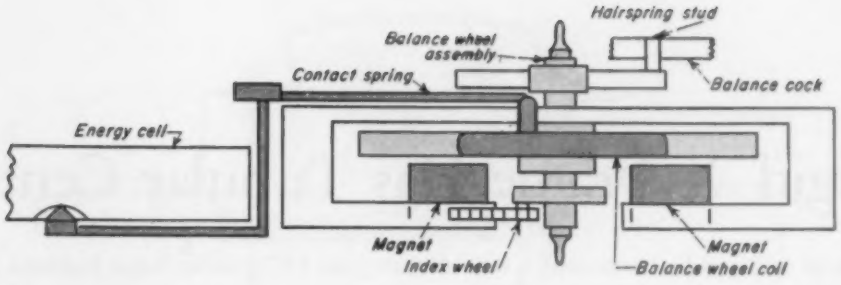




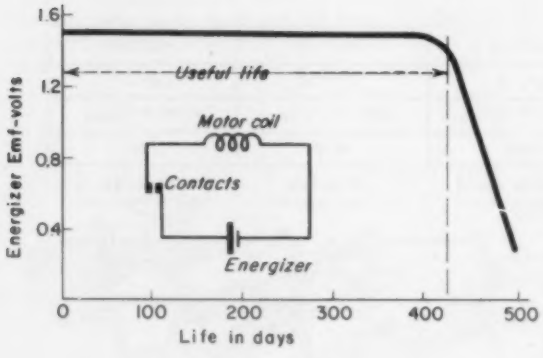
Design objective was to make a watch, electrically driven and about normal watch size, which would run a year on one energy cell. Movement size was limited to 1 in. max dia and ¼ in. max thickness. These requirements made energy source and motive principle the primary design considerations. A motive unit with a moving coil and fixed permanent magnets was selected as best solution to the space problem, but created problems of getting sufficient flux in the air gap and an adequate number of turns in the coil. A specially processed platinum-cobalt alloy was developed with the necessary magnetic properties, and the coil was wound with 0.0006 in. dia copper wire to obtain the required back-emf. The dry cell energizer, developed in cooperation with the National Carbon Co., has a low energy release rate and a long life. Energizer is held in the movement and a recess in the case ring by a clamp which locks like a safety pin.

Magnet alloy is 70 per cent platinum and 30 per cent cobalt, specially heat treated to develop properties suitable for this application. Residual flux density (B_r) is 6000–7000 gauss, coercive magnetization force (H_c) is 4200–4500 oersteds, and the maximum energy product (B_dH_d) for the demagnetization curve is 7 to 8 x 10^6 Gauss-Oersteds. These characteristics allowed the motor magnets to be designed with an optimum L/D ratio to meet space requirements, and still retain sufficient flux density to obtain high motor efficiency. Motor magnets are 0.090 by 0.083 in. Curves compare operating characteristics of platinum-cobalt and Alnico V magnets with selected L/D ratio. Coercive force necessary to demagnetize platinum magnets is greater than that obtainable with usual types of demagnetizers used by watchmakers.

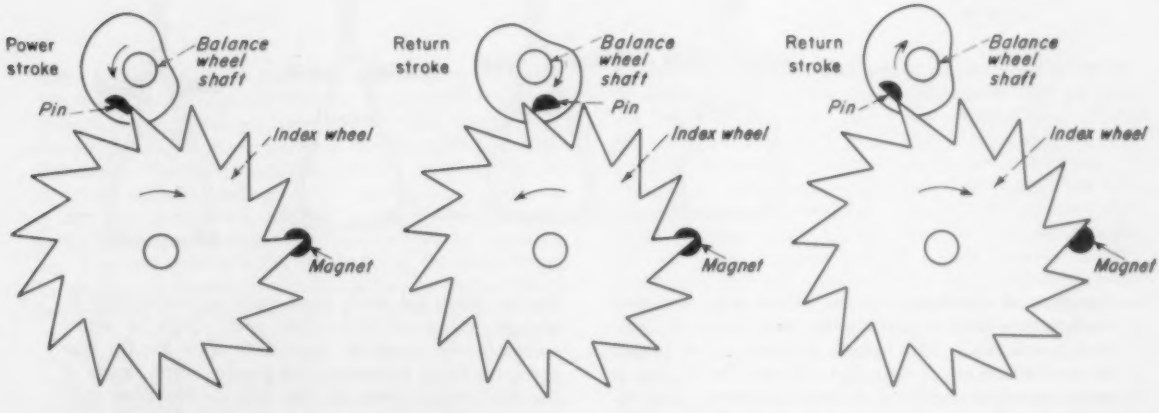




Motor coil is energized when contact on oscillating balance wheel momentarily closes energizer circuit through a contact spring, which extends over the movement from insulated posts. Magnets are magnetized before components forming flux circuit are rigidly assembled into pillar plate to simplify assembly operations. Building these parts into the pillar plate prevents service shocks from changing airgap and motor rate. Watch has a seconds setting feature, and pulling crown out to setting position stops the motor. When mechanism is in setting position, balance wheel is held so motor contacts stay open. This prevents draining energy cell when watch is not in use. As motor is not self starting, this action is used to compress hairspring sufficiently to oscillate balance wheel and start motor when the crown is snapped back into running position.



Energizer is 0.440 in. dia and 0.125 in. thick. It is rated at 60 ma hr, and will run the watch over 1 year. The oscillating balance wheel motor makes 2.5 contacts per sec, and draws current pulses from the energizer at a rate of about 6×10^{-6} watt. Motor was designed for 50 to 60 per cent electrical efficiency to constrict rate of energy release to extend life of energizer. Failure is rapid after a useful life of about 425 days.

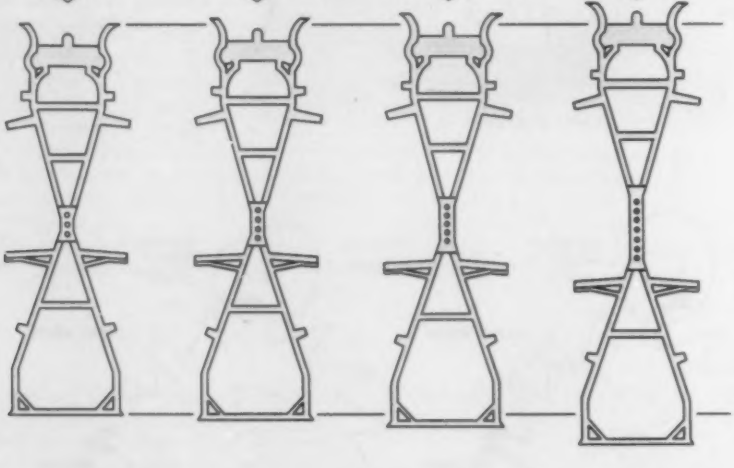


Indexing mechanism transmits energy from oscillating motor to gear train which drives hands. An eccentric pin on the balance wheel shaft drives the toothed wheel which indexes over a small magnet. On power stroke, wheel is advanced one tooth. On return stroke, wheel is moved back only about $\frac{1}{4}$ of tooth space because of tooth geometry and flat side on pin. When tooth is released by pin, indexing magnet pulls it forward to the centered position. Replacing the mainspring and barrel assembly with motor on balance wheel, and the escape wheel and pallet with this indexing mechanism makes the electric watch have $\frac{1}{3}$ less parts than a self-winding mechanical watch. Non-contact indexing action of magnet avoids high energy loss from friction in standard escapement mechanism driven by a wound-up mainspring.

Rigid X Frame Has Tubular Center

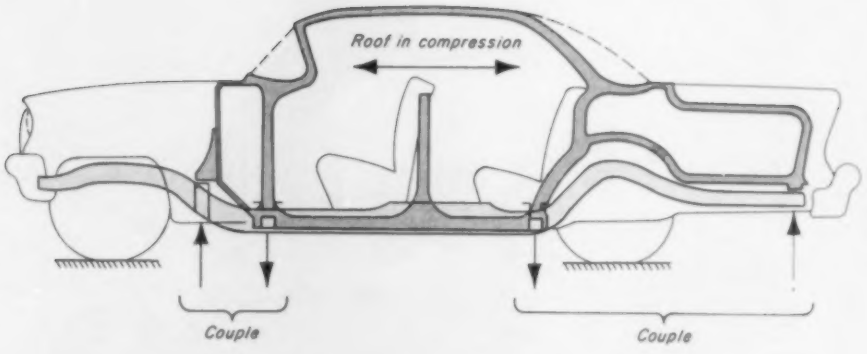
Arranged as an X-shaped backbone, with a tubular center, the 1957 Cadillac frame facilitates a substantial reduction in floor height while allowing an increase in the dimensions of structural members in critical areas. Previous reductions in car height have come out of space available for structure, and have made the problem of the structural designer increasingly difficult. Developed jointly by A. O. Smith Corp. and Cadillac engineers, this frame is a new approach to the problem of making automotive structures satisfactory from the aspects of performance and manufacturing economy which still meet the demands of styling, which determine utility and saleability of the product.

Weight	394 LB	406 LB	417 LB	453 LB
Max bend defl	.071 in.	.072 in.	.077 in.	.085 in.
Torsional rigidity	3432 lb-ft/deg	3203 lb-ft/deg	3010 lb-ft/deg	2576 lb-ft/deg
Torsional eff	857	829	808	770
	125 in. WB	129 in. WB	133 in. WB	146 in. WB

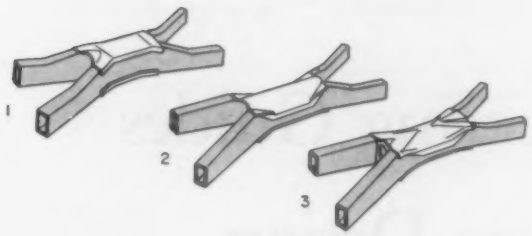


Effect of wheelbase variation

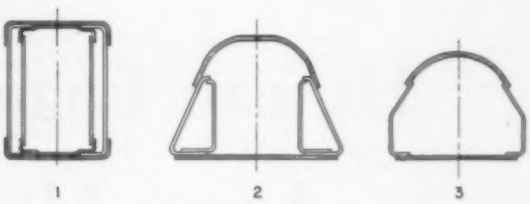
Variation of wheelbases was one of the most important matters considered in applying this basic design to Cadillac's production. The normal compliment of models involves wheelbases of 129½, 133, 150 and 156 in., and as some models are produced in limited numbers, it is impractical to have special tooling for each wheelbase. By lengthening the midsection to provide for wheelbase increase, the same basic tooling suffices for all models. A test program explored the loss in efficiency resulting from departing from a common intersection point for the four X-member legs. While the wheelbases were not those used in production, it was found that extending the central tunnel section would not greatly reduce stiffness, and that changes which did result could easily be compensated by changes in gage in the principal parts. Tools for higher volume models could be inserted to allow for the gage changes without substantial cost penalty. Final design of the 1957 model frame for the 150 in. wheelbase eight passenger car is lighter and more rigid than its 1956 counterpart. Results of these tests on extending the center tunnel length, indicate the frame need not be a true X and should more properly be called a tubular-center X-frame. These tests also showed, as it was not necessary to widen the rear of the propellor shaft tunnel to make the rear legs diverge, the small size tunnel desired by Cadillac could be obtained without penalty.



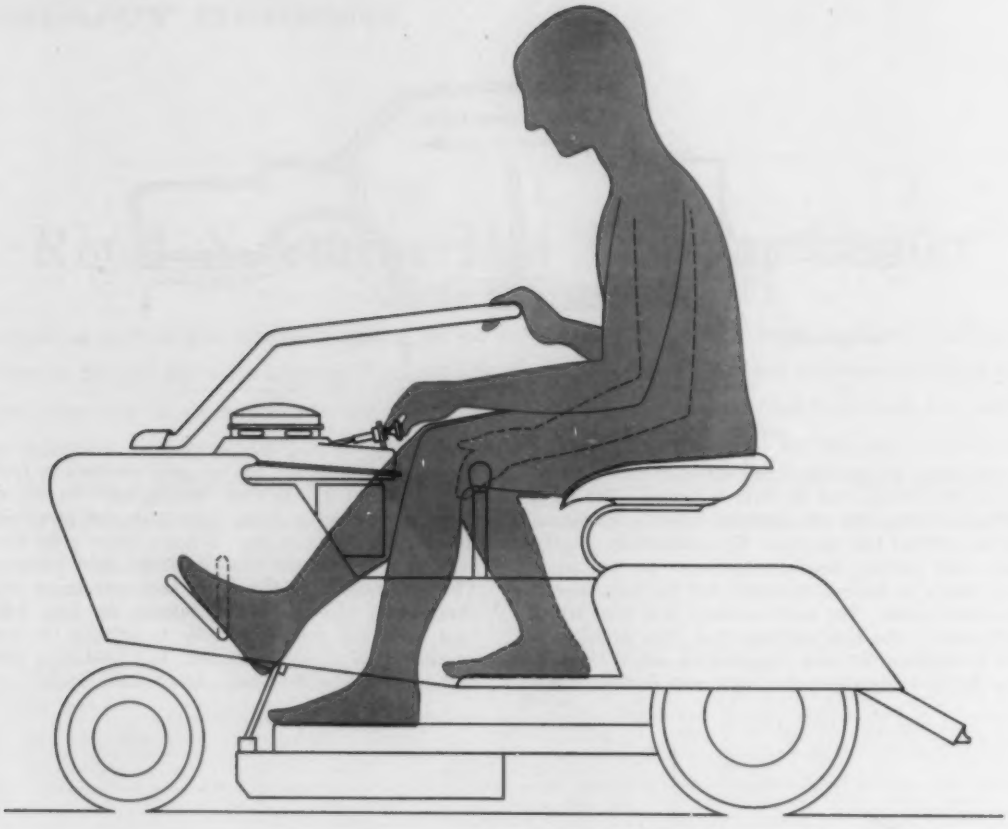
Body roof makes an important contribution to the structural rigidity of the vehicle, but its effect is limited. The trend toward lighter and smaller roofs prevents designing the passenger car as a stressed skin structure. The understructure is the principal load carrying member, reinforced by the superstructure insofar as its own limitations and the limitations of its attachment allow. The under structure is a beam which tends to rotate in the front and rear areas. This deflection is resisted by couples in the body side structure, and by compression in the roof. As the roof is light and shallow, it has little bending resistance, but has good resistance to compression. This lets it help resist bending loads on the understructure. It can also absorb shear loads, and contributes to the overall torsional rigidity. When a center pillar exists, it helps prevent the roof from buckling under compression. Throughout the midsection of the body, attachment between chassis frame and body only reinforces the body floor for local loads, and contributes little to utilizing the roof to increase overall structural rigidity. Full reinforcing effect is obtained with firm attachments at a few key points.



Three tunnel shapes were studied when developing the frame. The first proved structurally effective but required too much space in the rear passenger compartment. The second shape was satisfactory for space but its formation resulted in high deflections. The third shape was selected for production as it proved optimum both from the standpoint of space required and performance. Tubular center section contour, particularly where it branches out to merge with the extending legs, is an important factor in the rigidity of the entire frame In one test, an increase in torsional stiffness of the complete frame of over 20 percent was obtained by changing the contour of the top tunnel member, without increasing section size, material thickness, or weight. Bulkheads or shear plates at ends of tunnel section were also found desirable as they increase torsional efficiency. The 1957 Cadillac frame has a bulkhead at the front end of the tunnel, and a short crossmember just behind the tunnel for this purpose. When torsional loading is applied to the frame, one front beam and the diagonal rear beam are loaded downwardly while the opposite members are loaded upwardly. This results in a combination of cantilever bending and torsion in the legs themselves and a condition of almost true torsion at the center.



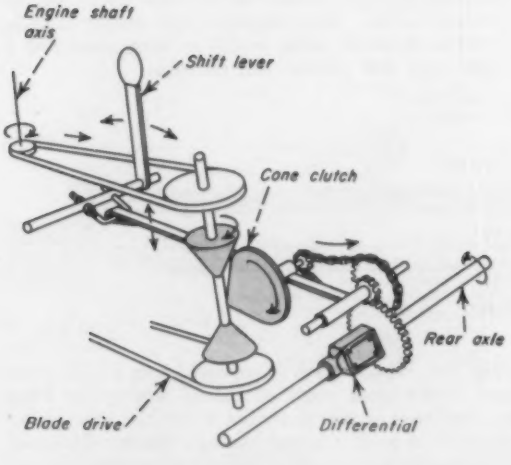
Distribution of metal within center section was also studied. As material furthest from the neutral axis is most effective, the third section proved best. This construction is simple and straightforward from a manufacturing standpoint and provides for a smaller tunnel size in the body floor. It requires an increase in tunnel size of not more than $\frac{3}{8}$-in. radially beyond that which is needed for the propellor shaft clearance alone. Space for the frame in front compartment did not prove a serious problem. Front floor is normally higher than the rear floor by several inches because requirements are different for seating and head room, and because clearance is required for the transmission. Also, the high degree of rigidity in the center of the frame has allowed for a frame depth reduction in the front seat area without a loss in efficiency of the overall unit. Cost is always a subject of great interest and importance in automotive design. Comparisons between different designs are difficult to make because detail requirements of each vehicle have considerable effect on costs. Detailed evaluations have proved this basic design is little more expensive than recent conventional frames. It is less costly than any of the alternative designs proposed to date for very low floors.



Human Engineering Guides Lawn Mower Design

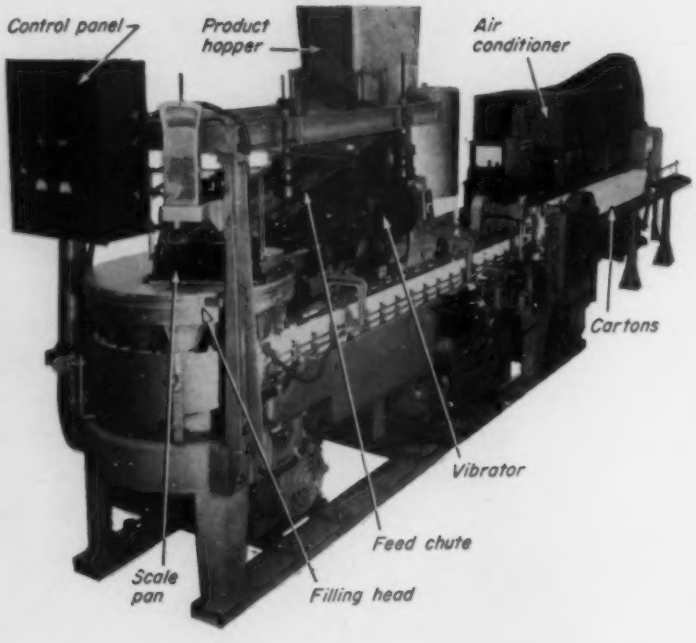
Human dimensions were considered an integral part of the design problem when the Porter-Cable Machine Co. of Syracuse, N. Y. designed a riding, gasoline-powered lawn mower to compete in the home equipment market. To coordinate styling, function, and good manufacturing practice, the company's industrial designer was made a key member of the design team. Dealers were surveyed by the sales department to discover characteristics required in a successful mower, who made the purchase, and which family members used it. Basic human engineering design objectives included comfortable seating, easy steering, simple controls in natural positions, and comfortable leg placement. Also, requirements of a low center of gravity and four-wheel support were included for stability when operating on sloping lawns, and to increase the operator's feeling of security.

Sales survey indicated mowers were purchased by the man although all the family used and was interested in the product. Although the industrial design elements were aimed at pleasing the whole family, emphasis was placed on items appealing to the man, and to his son who may be along when the purchase is made. Machine had to be rugged, not over-styled, and appear able to do its job. A general configuration resembling the family car or a small tractor was the factor intended to attract the younger male. As women are sensitive to line, color, massiveness, and ease of control, these elements were coordinated into the design in a way calculated to attract the feminine operator. Taken together, these requirements set up the basic configuration for initial layouts. To avoid a too massive appearance, the machine was finished in 2 colors. Metallic green, used on the lower part of the unit, blends with outdoor surroundings, but avoids a farm implement look and increases the appearance of stable weight distribution. An off-white, used on the upper portion, prevents a too massive appearance and ties the hood, engine, and seat into an integral unit.

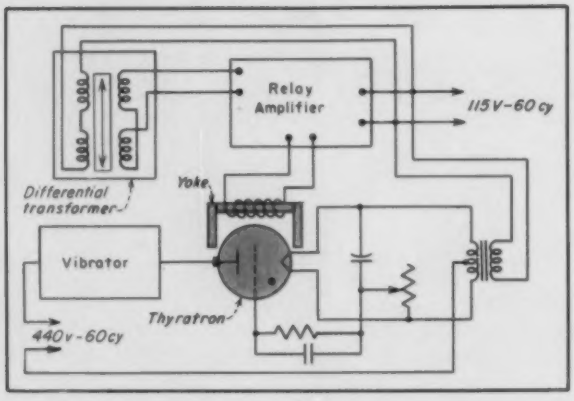


Mechanical drive system includes a differential in rear axle to prevent gouging the turf when turning, and uses a friction cone clutch to reverse the machine. As cutting blade and its housing pivot about rear axle when raised to clear rocks, this part of the drive is simplified by taking power off clutch shaft at the rear. Belt drives avoid need for critical assembly tolerances and alignment. Placing engine and clutch shafts in the vertical plane, and using a simple cone clutch to obtain a reversible rear wheel drive, makes a practical, low cost system which requires little maintenance. Also, transmitting power in this way keeps drive mechanism within the "U" shaped channel which forms frame of the machine. Note the simple control for changing direction; mower is driven in direction lever is moved. Shearing channel sides diagonally from center to front avoids a boxlike appearance and makes the channel easier to fabricate. Cowl and rear wheel enclosures are designed so they are made with some draw dies; additional operations are performed on these basic parts to fair cowl into the engine. Steering arm, used in place of a steering wheel, fends off shrubbery, is simple to make, and allows operator to make sharp turns without putting his body off balance. Most comfortable seat proved to be standard implement seat, with a contour evolved from long use.

Energy input to a vibratory product feeder is controlled by a scale to keep package weight within set limits in this carton filling and sealing machine made by the Stokes and Smith Co., Philadelphia, Pa. Cartons are bottom sealed, filled, and top sealed at a rate of 350 per min. Machine is especially suited for packaging free-flowing products in small cartons, where accurate weight is critical.

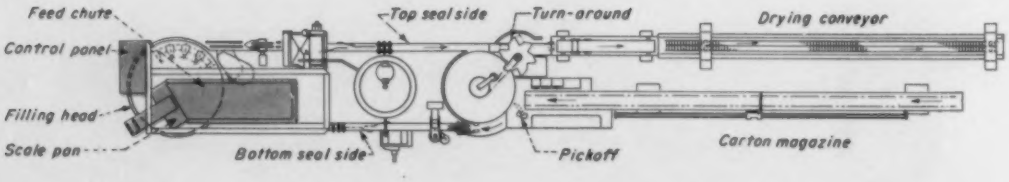


Weight-Controlled Vibratory Feeder



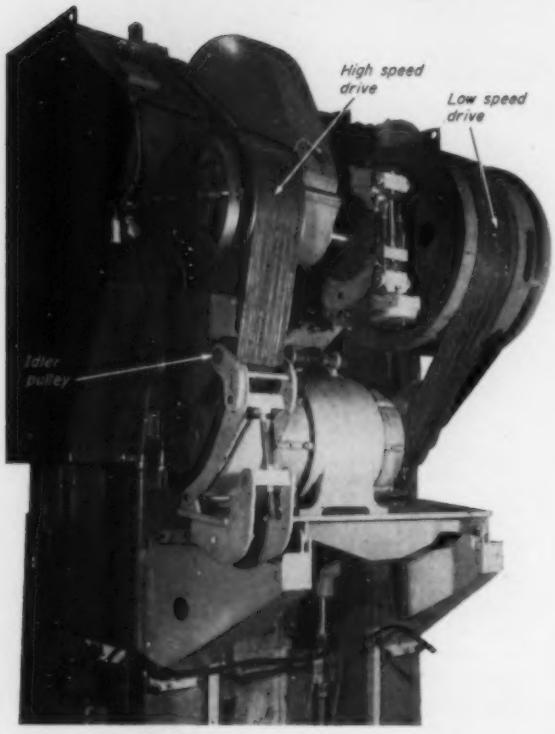
Scale unbalance is measured by a differential transformer, and its signal is amplified and used to set firing point of a thyratron which controls current flow to the vibrator. This system was designed by the Automatic Temperature Control Co of Philadelphia, and uses modified version of their Atcotran control relay. In standard version, transformer signal is amplified by a phase-sensitive circuit to energize either of 2 relays, depending on direction of departure from a null position.

In this application, transformer always operates on one side of null position, and the amplitude of its signal is used to modulate current flow through a single coil. Coil (from a telephone relay) has been fitted with pole pieces and used as a yoke around the thyratron which controls vibrator current. Coil's magnetic field deflects electron beam in thyratron, giving control of firing point over a wider range than possible with grid alone.

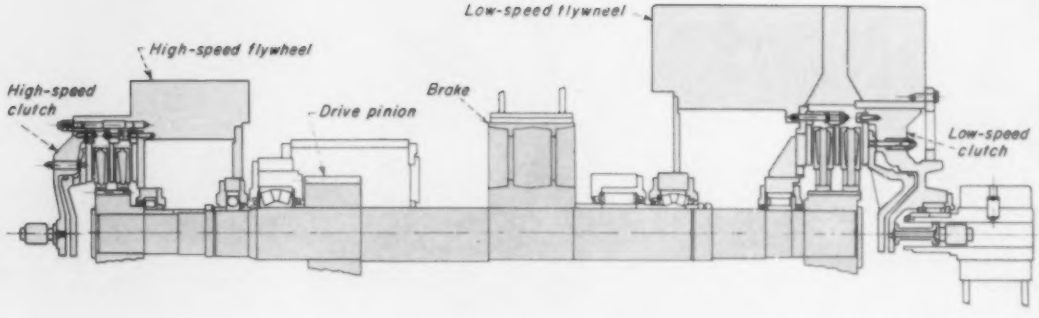


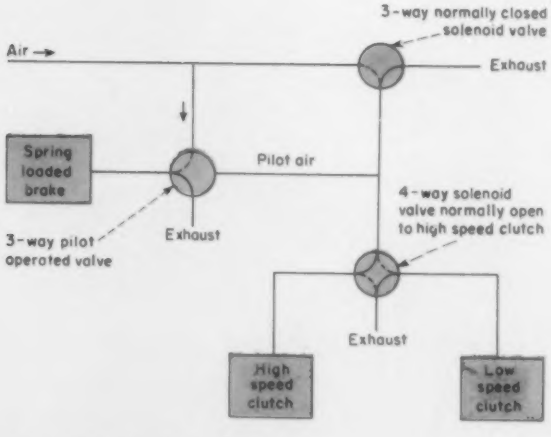
Cartons are plucked from magazine by an oscillating suction pickoff, and opened as they are positioned in a rotating chuck. Next, they are fed through bottom sealing section, where flaps are pre-heated for better adhesion before glue is applied. A conveyor belt carries them to rotating filling tubes which guide flowing product into the cartons as they pass under an inclined weighing pan. Weighing pan is suspended from a scale which measures instantaneous weight of material flowing into filling tubes. This value is related to, but is not the same as the actual weight of product in each package. Another interesting aspect of this design is use of a standard air conditioning unit to harden glue as cartons move down drying conveyor.

Two-Speed Press Drive



Two flywheels driven at different speeds by the same motor are alternately connected to the press driveshaft by air-operated clutches. The low speed drive is used for the drawing cycle, while the high speed drive raises the slide and then lowers it to the work for the next draw. Designed by the Federal Machine and Welder Co., Warren, Ohio, this system will increase the production of long stroke mechanical presses up to 50 percent.

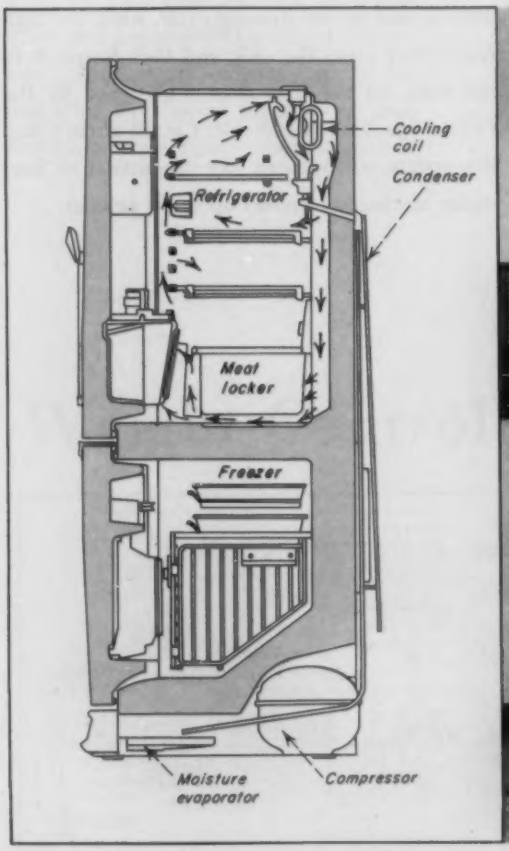


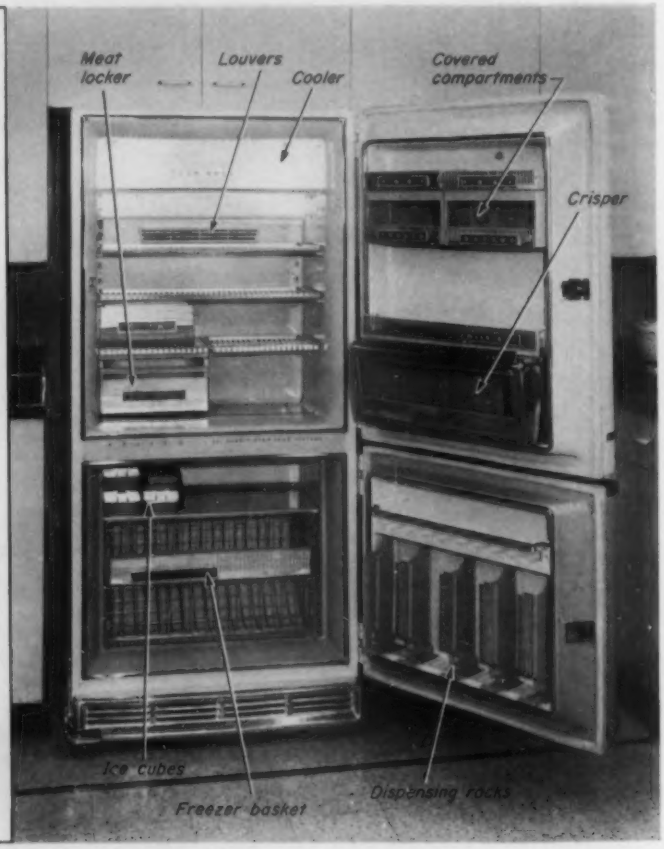


As the draw is made in 90 deg or less of crankshaft rotation, the remaining 270 deg only raises and lowers the slide. To reduce time used for this part of the cycle, crankshaft speed is increased by switching to the high speed drive. Flywheels are driven by a double-shaft extension motor through V belts. Note idler pulley used to adjust belt tension on high speed drive. Press operations are sequenced by cams in a drum-type limit switch which actuates solenoid valves in the air circuit. With press at top of stroke, the 3-way solenoid valve is energized so air pressure is applied to the high-speed clutch and pilot valve which disengages brake. At a preset point in down-stroke, the 4-way solenoid valve switches air supply to the low-speed clutch, and at bottom of stroke, returns it to the high speed drive. When slide is brought back to its top position, both 3-way valves act to disengage the drive and engage brake.

Refrigerator Has 3 Temperature Zones

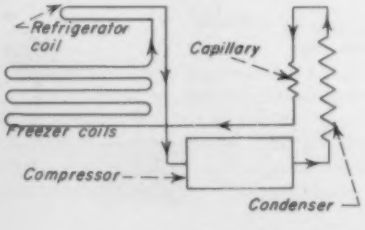
This Philco refrigerator uses a single temperature control to maintain different temperatures in its meat locker, refrigerator food compartment and freezer section. Chilled air is channelled directly to a fresh meat locker in the refrigerator compartment to keep meats ready for use at the proper holding temperature. Passing this air around the meat container, rather than into it, reduces moisture loss to maintain product appearance.



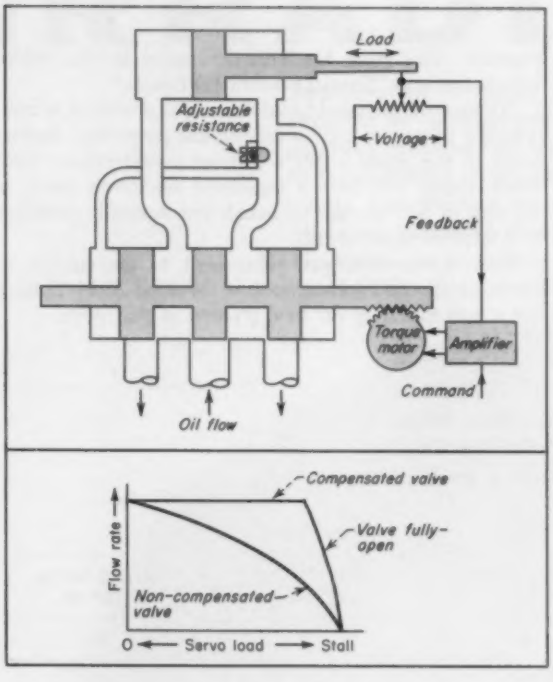


Chilled air moves down a duct in back wall, and divides into 2 streams. One stream flows directly into refrigerator compartment, while the second stream flows through meat locker before entering this compartment. Meat is contained in a flanged porcelain pan which slides in guides under bottom shelf. Only moisture loss is from diffusion through clearance spaces, as the chilled air flows through area between bowl and walls of the meat locker. In addition to meat locker, covered compartments in door condition butter, humidify cheese, and keep vegetables and fruit fresh by reducing moisture loss. Freezer compartment has cooling coils in top, back, and bottom, as well as in the shelf. Adjustable racks in freezer door hold and dispense cans or cartons while bulky packages are stored in a slide-out basket. Unit is self defrosting; moisture drains to a pan under the freezer where it is evaporated into the room air by an electric heater.

Heat transfer surface is divided between coil sections in freezer and refrigerator compartments in proper ratio to keep temperatures within design limits although controlled from the refrigerator area. Thermostat is designed to cycle chilled air temperature between 0 and 38 deg F. Freon 12 vapor flows through freezer coils first, then to the refrigerator coils Freezer temperature is held about 0 deg F, meat locker about 33 deg F, and the refrigerator compartment about 38 deg F. Temperature cycling defrosts cooling coil and reduces de-humidifying effect; heater which evaporates excess moisture is thermostatically controlled.



Self-Compensating Valve



An electro-hydraulic control valve which automatically compensates for variations in load has been developed by Cyrus Beck of Philadelphia, Pa., and is manufactured by the Automatic Temperature Control Co. of Philadelphia. An adjustable flow resistance, built into the valve, develops a feedback pressure across the spool which controls rate of response to load position signals.

Valve spool is positioned by force generated in torque motor, which is proportional to a command signal. Spool opens valve ports until pressure drop across adjustable resistance develops a feedback force on the spool equal to force exerted by torque motor. Servo piston moves until its position-feedback signal balances the command signal, and at a rate proportional to the position error. Gain is independent of load and fluid pressure variation within range of compensation. Compensating ability decreases as valve approaches fully-open position.

A hydraulic multi-cycle tracer lathe made by Sundstrand Machine Tool Co., Rockford, Ill., makes 2 roughing cuts, a semi-finish cut, and a finish cut in one automatic cycle from a single template.

Pulsation amplitude of a vibratory feeder is controlled electronically by scale readings in the filling mechanism of a carton filling and sealing machine made by Stokes and Smith Co., Philadelphia, Pa.

Eccentrically weighted parallel shafts, mounted on self-aligning bearings, vibrate the rolls of a power roller at 2400 cpm. Made by Rolcor Industries Inc., Minneapolis, Minn., this 1½ ton machine has the compacting ability of an 8 to 10 ton unit which uses static weight alone.

Separate electric motors are used for driving the wheels and brooms of a new battery powered sweeper made by Wayne Mfg. Co., Pomona, Calif. Using only the driving motor when the unit travels without sweeping allows it to operate for a full 8-hr shift before recharging.

Nylon wheels with stainless steel bearings are used on overhead conveyor chain, made by Richards-Wilcox Mfg. Co., to reduce noise and resist chemical corrosion.

A single probe is used for both plane and depth control in an electronic-hydraulic tracer-control system for machine tools made by Tracer Control Co. of Hazel Park, Mich.

Movable upper and lower platens, which synchronize with forward motion of the strip stock when work is punched, allow higher strip feeds in a "Flying Press" made by the Wean Equipment Co., Cleveland, Ohio. This design approximately triples output when making parts such as gaskets, and in progressive die work.

Cans are packaged in wrap-around box-board carriers at speeds up to 120 carriers a minute with a machine developed by Robert Gair Division of Continental Can Co. Carton wraps around cans from the top down and is glued and locked at the bottom. Carton feeding mechanism uses both suction cups and mechanical impellers.

Extruded alloy steel tubes are used to form hollow aircraft propeller blades which require welding only to close the tip. Additional strength is provided by a rubber rib injected into the center of the blade and vulcanized in place. Process is used by Propeller Division of Curtis Wright Corp., Caldwell, N. J.

Placing a temporary plexiglas cover over commutators cooled by an air blast enables Glenn L. Martin Co. to inspect this part of aircraft generators under operating conditions.

Seventeen different size parts for can body making machinery are made from a single basic investment casting by American Can Co.

More On Surface Finish Inside Tubes

In June of 1956, the suggested procedure on "How to Measure Surface Finish Inside Tubes," by Dr. C. R. Lewis, representing the Joint Consumers and Producers Committee of the Formed Steel Tube Institute, was published in *Product Engineering*. See procedure below.

Based on the use of this procedure, the Technical Committee (Carbon) of the Formed Steel Tube Institute, after long research and study, developed Table I for microinch finish on electrical resistance welded tubing, which gives the approved brackets for acceptance of special smooth finish for tube which has been cold drawn over a mandrel. This grade has been designated by the welded tube industry as "Special Smooth ID Finish."

"Drawn over mandrel" grade usually is produced to meet specified tolerances and/or mechanical properties. Surface finish in this grade is not a primary consideration. Such tubes usually will have a maximum microinch finish in the area of 125 average, although not normally produced to a finished requirement.

Table I was developed subsequent to the current revision of the *FSTI Handbook of Welded Steel Tubing*, but it will appear in the next revision of that work.

TABLE I—FOR MICROINCH FINISH
(for Special Smooth ID Finish Only)
Maximum Average Readings (Microinch)

Outside diameter	Wall Thickness		
	0.065 and under	Over 0.065 to 0.150 incl.	Over 0.150 to 0.187 incl.
1/2 to 2 1/2 in. incl.	40	45	55
Over 2 1/2 to 4 1/2 in. incl.	40	50	60

Suggested Procedure

for Making Microinch Readings on Interior Surfaces of Cold Worked Tubing (Not Polished or Ground) ½ in. ID and Larger

Section 1. Measurements on tubing with longitudinal or no predominate lay should be circumferential on the inside surface of the straight tube, prior to any fabrication in a plane approximately perpendicular to the tube axis. Measurements on tubing with circumferential lay should be longitudinal.

Section 1-A. Measurements should be made not less than 1 in. from the end.

Section 1-B. Measurements should be made at four positions approximately 90 deg apart or over a complete circumference if the trace should otherwise overlap.

Section 1-C. The length of trace should be in accordance with Section 4.5 of ASA Standard B46., latest revision. (N[illegible] less than 0.600 in. long).

Section 1-D. A minimum of three such measurements should be made spaced not less than ¼ in. apart along the longitudinal axis.

Section 1-E. The numerical rating shall be the arithmetical average microinch of all readings taken. Each reading to be averaged should be the mean position of the indicator during the trace, any momentary meter excursions occupying less than 10 per cent of the total trace should be ignored.

Section 1-F. A deviation in numerical rating in various parts of a tube may be expected. Experience to date indicates that a variation of about plus or minus 35 per cent is normal.

Section 2. Instruments should meet the specifications given in ASA Standard B46., latest revision.

Section 3. Mechanical tracing is preferred. If hand tracing is used, the speed of trace should not vary by more than ± 20 per cent from that required to give the appropriate cutoff. The 0.030 in. roughness width cutoff should be used.

Section 4. Microinch determination only refer to roughness of areas that do not contain a defect, injurious or otherwise. Such defects as seams, slivers, pits, laps, etc., are subject to ordinary visual inspection in accordance with applicable specifications or trade customs and have no relationship to roughness.

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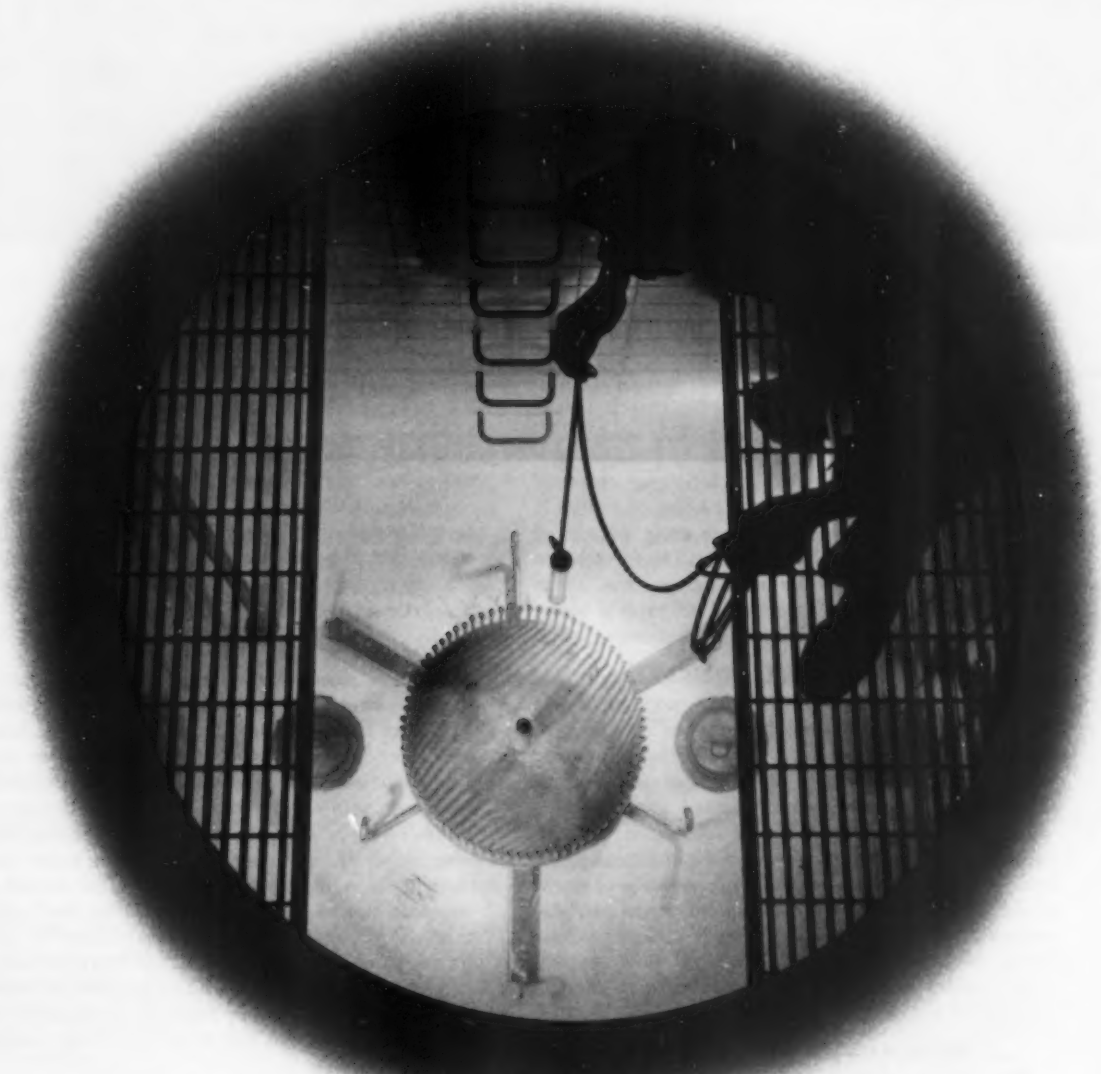
IRRADIATION

Radiation, by changing properties of materials, creates 'new' materials. Whether the changes are good or bad requires careful evaluation of each application. Theory of radiation change in metals and plastics is currently in the formative stage and the field is broad; nonetheless, this new energy source has sparked an across-the-board re-evaluation of standard engineering materials and intensive development programs to produce, by irradiation, new classes of materials with prescribed properties. In this special report, we present four articles on various aspects of this subject.



- **HOW METALS CHANGE BY IRRADIATION**
- **HOW IRRADIATION AFFECTS ALUMINUM ALLOYS**
- **HOW PLASTICS CHANGE BY IRRADIATION**
- **GRAFTED PLASTICS BY IRRADIATION**

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HOW METALS CHANGE BY IRRADIATION

Three basic concepts of bulk property change and their significance in engineering design.

HOW IRRADIATION AFFECTS ALUMINUM ALLOYS

An appraisal of data on neutron-bombarded aluminum alloys.

HOW PLASTICS CHANGE BY IRRADIATION

Polymerization by irradiation may produce low-cost plastics with unusual properties.

GRAFTED PLASTICS BY IRRADIATION

Plastics with desirable properties are combined by nuclear-particle bombardment — a modern shotgun wedding.

H. I. RAIKLEN, *metallurgist*
Atomic Energy Division
Sylvania Electric Products, Inc.

How METALS change by irradiation

EXPANDING nuclear reactor construction for power or research has increased the understanding of radiation effects on meals. Although there are many sources of radiant energy, neutron bombardment from controlled fission is the prime nuclear collision process. Three basic concepts have been proposed to explain many metal changes ascribed to neutron irradiation:

DISPLACEMENT CONCEPT

Metal change by displacement is a mechanical concept. A neutron, having no charge, does not interfere with the atom electrons in a metal. With high kinetic energy, it proceeds until it collides with an atom nucleus, displacing an energetic atom to some other position within the lattice. Result is an interstitial atom, a vacancy at the original atom site, and a change in direction of the bombarding neutron. This sequence of events is shown in (A) and (B). Displaced atoms can also elastically collide with other atoms if sufficient kinetic energy was imparted by the original colliding neutron. These created lattice defects are manifested by changes in physical and mechanical properties.

THERMAL SPIKE CONCEPT

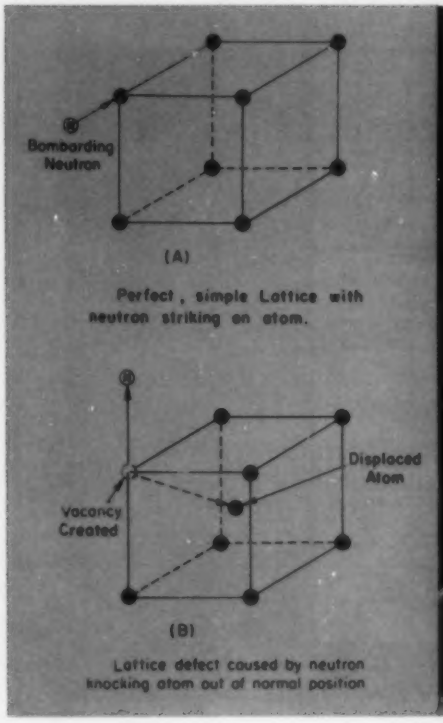
Here, bombarding neutron energy is lost to atoms adjacent to the particle path, creating intense local heating. This energy conversion, confined to a small volume, results in sharp temperature gradients or "thermal spikes." Resulting temperatures, calculated in the order of 1300-2200 K for 10^{-10} sec, are sufficiently high to melt and possibly to vaporize the metal locally. Rapid conduction of heat to adjacent areas result in distorted regions at the spike sites upon solidification, effecting properties of the metal on a macroscopic scale.

IMPURITY ATOM CONCEPT

Property change under neutron bombardment also can be interpreted metallurgically in terms of solution hardening. Here, certain alloys are formed by solution of a secondary component metal in the major component metal at elevated temperatures. Precipitation from super-saturated solution changes many alloy properties. By the impurity atom concept, the bombarding neutron is captured by the struck atom, forming a new atomic element. This 'impurity' atom acts as the second component metal in the solution-hardening analogy. For example, a neutron captured by a rhodium^{103} nucleus forms radioactive rhodium^{104}. This decays by beta particle emission to palladium, which becomes the impurity atom. Property changes by formation of impurity atoms are thought to be less significant than those caused by displacement.

NET EFFECT DEPENDS ON APPLICATION

Irradiation effects on metals are large in some instances, negligible in others. Many variables coexist:



CHARPY IMPACT TESTS on neutron-irradiated specimens being run remotely by Westinghouse engineer. Residual radiation in specimens requires heavy shielding and remote-handling devices such as manipulator claw (center) for changing specimens.

type, intensity and dosage of radiation; type, purity and initial state of the material; character, temperature and pressure of the surrounding medium. Whether property changes by irradiation are detrimental or beneficial is determined by the specific material use. To date, however, beneficial changes in bulk properties of metals by irradiation are not significantly different from those produced by conventional metallurgical methods.

Certain radiation effects can be removed; others cannot. Property changes caused by bombardment-induced formation of new elements are irreversible. Changes in hardness and resistivity, resulting from atomic displacements, however, can be removed by a process similar to the annealing of work-hardened metals. Heating the irradiated metal to the temperature at which the vacancy and interstitial atom can recombine restores original properties.

DR. H. H. HAUSNER, *vice-president – Nuclear Engineering Division, Penn-Texas Corporation*

How irradiation effects ALUMINUM alloys

Tensile and yield strength • Elongation • Corrosion resistance

AMONG metals, the behavior of aluminum under radiation is of special interest because of its wide application in nuclear reactors. Table I shows the neutron cross-section of aluminum in comparison with that of several other materials of construction. Low neutron cross-section makes aluminum the principal structural material of all early reactors, and of many present ones. In addition, it has good aqueous-corrosion resistance at moderately low temperatures. Subsequent tests have proved that this selection was wise, because radiation damage is relatively slight in the alloys used.

Aluminum is used in reactors for many different applications: fuel-core material containing fissionable materials, fuel cladding, in the coolant transportation system. Outside of the heart of the reactor, aluminum is used as a material of construction, for instruments, and in electrical and mechanical devices.

In most of these applications, aluminum is exposed to irradiation of different types and intensities. The effect on aluminum depends to a large extent on the initial

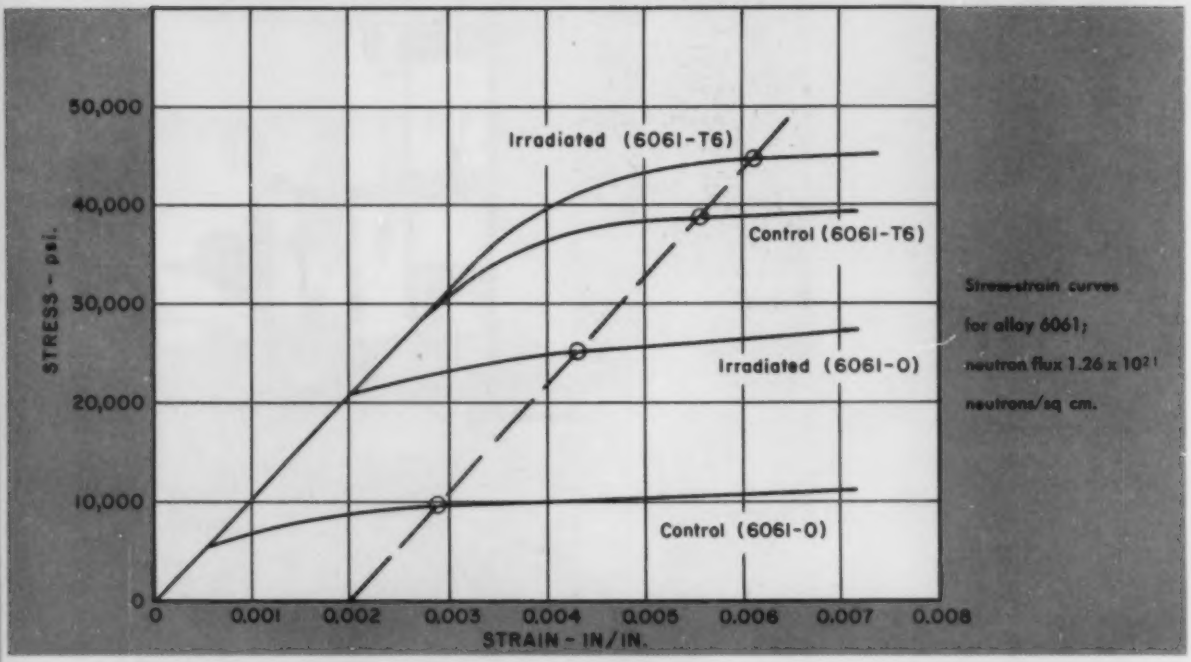


TABLE I
THERMAL NEUTRON CROSS SECTION OF VARIOUS METALS

Metal	Cross section in barns
Beryllium	0.009
Magnesium	0.059
Zirconium	0.18
Lead	0.18
Aluminum	**0.22**
Calcium	0.42
Sodium	0.49
Tin	0.60
Iron	2.40
Copper	3.6
Nickel	4.5
Titanium	5.8

state of the material, whether it is annealed or hardened, on the degree of cold deformation, and on the type and amount of impurities. All these variables usually determine the physical properties of aluminum. Generally, aluminum within the annealed condition is more reactive to irradiation than aluminum in the work-hardened or heat-treated conditions. Of principal interest here are changes in these properties:

1. density
2. tensile strength
3. yield strength
4. impact strength
5. rupture strength
6. elongation
7. hardness
8. creep
9. fatigue
10. corrosion resistance

Density and damping-capacity measurements have been made on high-purity single crystals of aluminum after an exposure of 2×10^{18} neutrons /sq cm in the Oak Ridge reactor. While an increase in damping factor was consistently observed after irradiation, its magnitude was such that it could not be attributed to neutron bombardment alone. No changes in density could be measured.

Tensile and yield strength of the alloys listed in Table II were studied in the Materials Testing Reactor at Arco, Idaho. Total neutron radiation exposure was 1.26×10^{21} neutrons/sq cm, with an estimated fast neutron exposure of about 1×10^{20} neutrons/sq cm. Specimens were water-cooled during irradiation, so that specimen temperature was approximately 150 F.

TABLE II ALLOYS USED FOR NEUTRON IRRADIATION TESTS

Alloy	Temper	Nominal Composition, per cent Mg	Cu	Cr	Fe	Mn	Zn	Others
1100	O — annealed H14 — strain hardened	—	0.20	—	1.0	0.10	0.10	0.15
5052	O — annealed H34 — strain hardened, stabilized	2.50	0.10	0.25	0.45	0.10	0.10	0.15
6061	O — annealed T6 — Solution annealed, aged	1.00	0.27	0.35	0.70	0.15	0.20	0.15
5154	— — cold reduced 50 per cent	3.50	0.10	0.25	0.50	0.10	0.10	0.15

TABLE III SUMMARY OF TEST RESULTS

Material	Condition	No of tests	Yield strength 0.2 per cent offset, psi	Tensile strength, psi	Elongation, per cent
1100-0	Control	8	6,800 ± 180	13,600 ± 320	38.2 ± 3.2
	Irradiated	25	17,100 ± 890	26,000 ± 2000	21.2 ± 1.2
1100-H14	Control	8	16,600 ± 250	17,300 ± 460	6.0 ± 0.6
	Irradiated	22	24,000 ± 450	26,000 ± 380	5.5 ± 1.2
5052	Control	7	14,700 ± 670	29,200 ± 450	34.0 ± 3.4
	Irradiated	22	22,900 ± 540	37,400 ± 490	30.6 ± 4.2
5052-H34	Control	7	29,500 ± 800	36,000 ± 700	11.2 ± 2.3
	Irradiated	21	36,400 ± 1000	44,700 ± 1200	14.0 ± 1.1
6061-0	Control	8	9,460 ± 200	18,050 ± 240	28.8 ± 2.8
	Irradiated	25	25,600 ± 460	37,300 ± 400	22.4 ± 0.8
6061-T6	Control	8	38,500 ± 740	45,000 ± 320	17.5 ± 1.0
	Irradiated	23	44,400 ± 670	50,600 ± 540	16.2 ± 0.7
5154	Control	8	47,800 ± 450	54,700 ± 500	8.8 ± 1.1
	Irradiated	17	50,800 ± 460	57,800 ± 510	12.5 ± 0.6

Changes in mechanical properties are summarized in Table III. These data are most revealing in many respects:

1. Both tensile and yield strength increase considerably by neutron irradiation, yield strength increasing much more than tensile strength.

2. The increase in strength is considerably greater for annealed specimens with more ordered crystal lattices than for hardened specimens with disordered lattices.

3. The increase in strength is lowest for aluminum with a greater amount of alloying constituents

4. Elongation decreases in many cases, with maximum decrease in annealed specimens, minimum decrease in strain-hardened specimens.

5. Aluminum with a greater amount of alloying constituents and strain hardened may even show an increase in elongation.

In addition, although elongation values for annealed material were reduced, ductility was greater than that obtainable by strain hardening to the same strength level. For example: irradiated, 5052 alloy has 37,400-psi tensile strength and 30.6% elongation; strain hardened to H34 tempered, it has 36,000-psi tensile strength and 11.2% elongation.

Lower irradiation level reduces the increase in strength, as shown by the data of Table IV on 1100 aluminum. These data also indicate a saturation of the irradiation-induced changes in physical properties. Investigation of the 1100-alloy water-cooling tubes in the Hanford reactor showed also that material exposed to fast neutrons has higher tensile strength, yield strength, and hardness, and lower electrical resistivity than material exposed to thermal neutrons only.

Elevated temperatures appear to offset strengthening of aluminum alloys by irradiation if the temperature reached during exposure exceeds the recrystallization temperature. For example, in pure aluminum exposed to a neutron flux of about 1.3×10^{20} nvt at approximately 275 F: tensile strength increased only 3% and elongation decreased 5%. Compared to changes shown in Table III, these are quite modest.

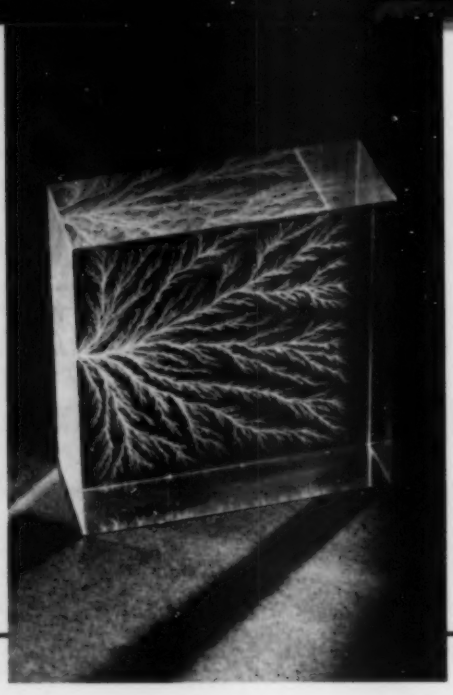
Creep characteristics of aluminum appear unaffected by either neutron or alpha-particle irradiation, based on data accumulated to date. Tests have been run with the alloy under bombardment, both with and without stress. Minor changes were observed. For design purposes, therefore, it is recommended that the normal creep rate of the metal be used.

Corrosion data on irradiated aluminum alloys is not yet available. Generally, however, in systems where the corrosion inhibition depends on the formation of a protective-oxide film, irradiation acts usually as a further inhibitor. In systems, however, where no protective films are formed, irradiation may tend to have a slight accelerating effect on corrosion. Aluminum usually forms an oxide film at certain corroding conditions; therefore, irradiation may improve its corrosion behavior.

TABLE IV
EFFECT OF FAST NEUTRONS ON TENSILE PROPERTIES OF HIGH-PURITY ALUMINUM

Exposure,* neutrons/sq cm	Specimen condition	Property change, per cent: Yield strength (0.2% offset)	Tensile strength	Elongation
7.5×10^{19}	Annealed	+100	+60	−67
	half-hard	+ 10	+ 6	0
	extra-hard	Very small		
15×10^{19}	Annealed	+100	+70	−67
	half-hard	+ 10	+ 6	0
	extra-hard	Very small		

*Energies greater than 0.5 million electron volts; temperature 30 C.



Lucite block after irradiation by 2-million volt Van de Graaff accelerator. High speed electron particles accumulate in molecular structure. Slight tap on block results in crazing effect as electrons create escape paths.

MICHAEL FERENCE, *associate director*
Scientific Laboratory
Ford Motor Company

DR. A. J. RESTAINO, *head, Nuclear Effects Unit*
Nuclear Division
The Martin Company

How **PLASTICS** change by irradiation

THE USE OF gamma and beta rays from radioactive sources, and of high energy electrons from accelerators has resulted in rapid development in the radiation chemistry of plastics. However, the effect of gamma radiation in organic polymers is significantly different from the effect in metals. This is because of the fundamental difference between the metallic and the covalent bond. When metals are irradiated, electrons are displaced, but not necessarily permanently. If electrical balance is restored, the system recovers its initial state. In organic polymers, however, chemical bonds are broken which yields fragments of different sizes and gaseous decomposition products. In metals, then, irradiation effects are reversible, whereas in organic polymers they are irreversible.

Gamma-rays interact with electrons at an energy level many times that holding the electron in the atom. Consequently ionization and free radicals occur. Although the energy of the ejected electron is less than that of the bombarding gamma ray, it will still be many times the electron binding energies and further ionizations take place. Net result is the formation of many ions and free radicals from the action of a single gamma photon.

Organic polymers are composed of interlinked molecular chains. Ion and free radical formation upon irradiation may occur in either the main or side chain of the polymer. Although bond cleavage occurs in either position, the net effect on the bulk properties of the polymer is different. Bond cleavage in the side chain produces further cross-linking and hence polymer strengthening; however, main chain cleavage generally leads to polymer degradation, with a marked change in tensile strength and other properties. Amount of change depends somewhat upon the molecular weight of the polymer employed.

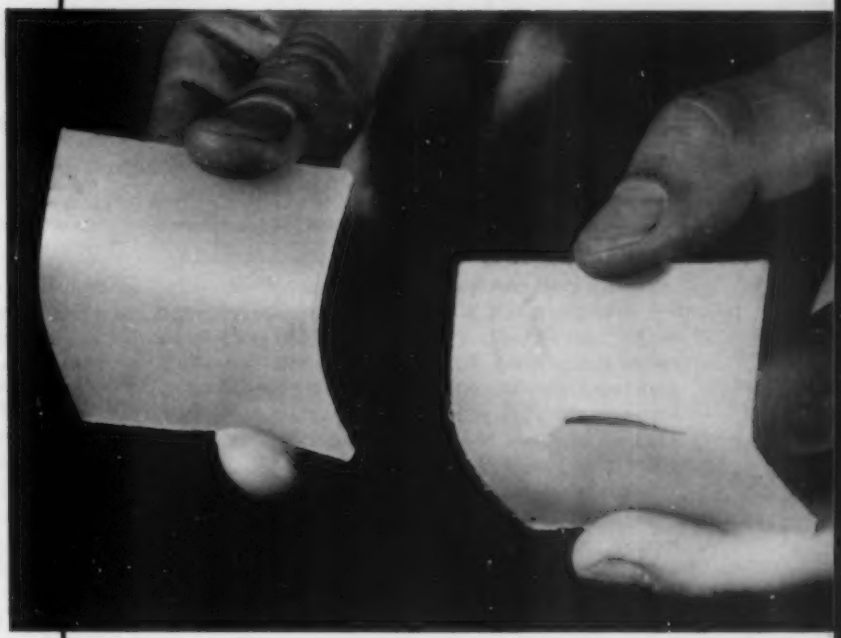
Bond cleavage can, therefore, yield either degradation or cross-linking. This does not mean that one or the other will occur alone. Actually, all polymers degrade and cross-link simultaneously when irradiated, but one effect predominates over the other, depending upon the structure of the polymer.

Radiation can, by free radical formation, initiate polymerization. It is possible, therefore, to radiation-graft a monomer to a polymer so as to control the properties of the grafted polymer. For example, if a polymer A is added to a monomer B, and the mixture irradiated, part of B will itself polymerize and part will form a grafted copolymer with A. By proper choice of conditions, formation of the grafted copolymer may be increased at the expense of B's polymer. Combining the physical properties of two different polymers in a controlled manner obviously has considerable practical interest.

Current obstacle to wider commercial use of irradiated plastics is cost, because this form of energy is more expensive than ordinary heat. The method must, therefore, be limited to those products which can be made economically in no other way. However, the steadily increasing number of radiation sources, as well as the reduction in their cost should give this technique wider application.

GRAFTED PLASTICS by irradiation . . . a modern "Shotgun" Wedding

DR. A. J. RESTAINO, *head*
Radiation Effects Unit
The Martin Company



Environmental stress-cracking resistance of irradiated polyethylene (left) is greater than before radiation (right). Corrosive medium, acetic acid at 75 C for 5 min.

RADIATION will interact with polymers (rubbers, plastics and fibers) to form ions and free radicals. If a monomer is placed next to a polymer and the combination irradiated, a propagation reaction will take place in which monomer units add to the radicals formed on the polymer. Each addition of monomer to a free radical will result in the formation of a chemical bond with simultaneous liberation of heat. These combinations are called graft copolymers.

GRAFT COPOLYMERS ARE MADE EXPERIMENTALLY as follows: A film or sheet of the polymer to be grafted is placed in a glass polymerization tube, Fig. 1, and the liquid monomer is added. The tube is then placed on a vacuum rack, the monomer frozen by immersion in liquid nitrogen, and the system degassed to remove oxygen which acts as an inhibitor in free radical polymerizations. After several thawing and degassing cycles, the tube is sealed under vacuum and placed in the Co-60 source (see cover). Time required for the irradiation depends upon the monomer and polymer to be grafted, the intensity of the radiation, the temperature and the degree of grafting desired.

THAT POLYMERS DEGRADE AND CROSS-LINK SIMULTANEOUSLY in a radiation field via free radical intermediates has been known for over a decade. The potential for producing graft copolymers by irradiation was realized only recently, however. This was based on the fact that if a vinyl monomer is added to a polymer containing irradiation-produced free radicals, the vinyl monomer can, through well known reactions, add to these radicals before it can produce cross-linking or cause degradation. Thus, graft copolymerization, induced by radiation, may take place at the expense of cross-linking and degradation in the matrix.

THIS IS SIGNIFICANT with polymers which degrade under the influence of radiation, because graft copolymerization may produce marked changes in the radiation stability and tensile strength of the original polymer. Often the single graft copolymer takes on properties of the separate polymers. For example, graft copolymers have been made in which the adhesive or dielectric properties of one polymer are combined with the tensile strength or heat stability of another.

FINAL PROPERTIES of a copolymer depend upon the manner in which the components combine. A copolymer of 60 A and 40 B may have different physical properties if the combination is a random copolymer, a block copolymer or a graft copolymer. These three types are illustrated schematically in Fig. 2. However, the fact that monomer B can be grafted to the polymer of A by irradiation does not necessarily mean that monomer A can be grafted to the polymer of B with the same efficiency. For example, styrene may be grafted to polymethyl methacrylate by gamma irradiation, but the reverse process is both wasteful and inefficient.

RADIATION-INDUCED POLYMERIZATION IS DIFFERENT FROM THERMALLY-INDUCED POLYMERIZATION. Under irradiation, molecular weight increases with temperature; with thermally-induced polymerization, the reverse is true. Rate of polymerization, however, increases with temperature in both cases. Consequently, when high temperatures are used to obtain quick reactions, (at dosage equivalent to catalyst concentration) irradiation produces polymers with higher molecular weight. This is significant because, in many cases, the higher the molecular weight the better the tensile properties.

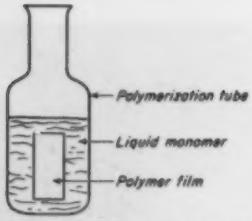


Fig. 1 — Polymerization tube for irradiating components of graft copolymers.

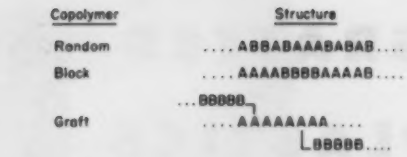


Fig. 2 — Three possible structures for copolymer with components A and B. Physical properties of each type are different, even though proportion of A and B in each remains the same.

Certain graft copolymers have been made thermally; for example, graft copolymers of polystyrene and methyl methacrylate, which are difficult to make by irradiation, have been by thermal polymerization. Other graft copolymers can only be made through irradiation; for example, a vinyl acetate-Teflon graft copolymer. Thermal synthesis of these two materials is extremely difficult, because Teflon is chemically inert.

THERE ARE TWO TYPES OF GRAFT COPOLYMERS, internal and surface. In the internal type, monomer polymerizes principally within the polymer film specimen; an example would be styrene and polyethylene. In the surface type, the monomer is grafted only on the periphery and not in the matrix; an example would be Teflon and vinyl acetate.

APPLICATIONS

ION-EXCHANGE MEMBRANES. Efficient and relatively inexpensive ion-exchange membranes have been made by treating the graft copolymer of styrene to polyethylene with chlorosulfonic acid. Ion-exchange membranes of this type have been considered for removing ions from sea-water and deionization of corrosion products in boilers and reactors. These membranes compare favorably in tensile strength, specific resistance and cost with those produced commercially. Radiation stability of this graft copolymer system is unusually good.

HEAT-RESISTANT RUBBER. Graft copolymers of acrylonitrile and rubber (including certain silicon rubbers) have improved the heat resistance of rubber while retaining elasticity. Quantitative data is lacking at present; however, this graft copolymer system is becoming industrially significant both here and abroad.

GRAFT COPOLYMERS WITH IMPROVED ADHESION. Heat resisting and insulating properties of Teflon may be extended to adhesive applications by graft copolymerizing with vinyl acetate. Adhesive joints to metal can be made conveniently by warming the vinyl acetate surface of the graft copolymer or solvent wetting (with benzene) and application of mild pressures. Commercial applications for this graft copolymer could be substantial since Teflon is difficult to bond because of its chemical inertness.

METAL-ORGANIC POLYMERS. Promising new moderator fuel elements and secondary neutron and gamma shields have been prepared combining polymers and metals by irradiation technique. The method involves graft copolymerization, chemical treatment and metal hydroxide addition. Organic polymers with a wide variety of metals can be made. The metal is chemically bound into the polymers, making the system homogeneous. Polymers of uranium, lead, lithium, iron and combinations thereof have been prepared and some of their physical properties have been evaluated, Table I. The relatively high values of atom density, N_H, the excellent heat and radiation stability of the polymers, and the fact that these polymers are homogeneous even at maximum metal content, suggests uses as moderator-fuel elements in the case of the uranium polymers, and shielding materials for some of the other metal-organic polymers. The addition of metals such as cadmium, aluminum, thorium and others is also possible.

Radiation-induced graft copolymerization is still in development; however, the possibility of polymers with combination properties is of industrial interest. Originally radiation produced graft copolymer programs were limited (in the U.S.) to fundamental research studies at Brooklyn Polytechnic Institute and Brookhaven National Laboratories in this country. At present, such companies as Martin, General Electric, DuPont, Westinghouse, and others both here and abroad, are actively engaged in the commercial development of graft copolymers.

TABLE I COMPOSITION AND PROPERTIES OF METAL-ORGANIC COPOLYMERS

Copolymer of	Metal	C	O	H	S	Density, gm/cu cm	$N_H \times 10^{-22}$	Softening Point, C
Uranium	12.92	70.65	5.5	8.99	1.92	1.36	7.35	310
Uranium	15.35	66.94	6.78	8.51	2.44	1.41	7.22	310
Uranium	39.00	46.50	9.10	6.10	2.50	1.61	5.90	310
Lithium	1.15	85.30	2.07	10.10	1.38	1.03	6.30	280
Lead	13.92	71.70	3.75	8.83	1.78	1.32	6.97	310

FURTHER READING on materials in nuclear environments:

"Nuclear Reactors Pose New Problems in Mechanical Design" April 1956 page 187. A 24-page staff report covering special requirements of materials, mechanical components and controls, with extended bibliography.

"Characteristics of Nuclear Reactors" May 1956 page 138. A 10-page staff report covering reactor types and factors defining their performance, such as: type of fuel, energy range, coolant, moderator and shield, control system and output. Bibliography appended.

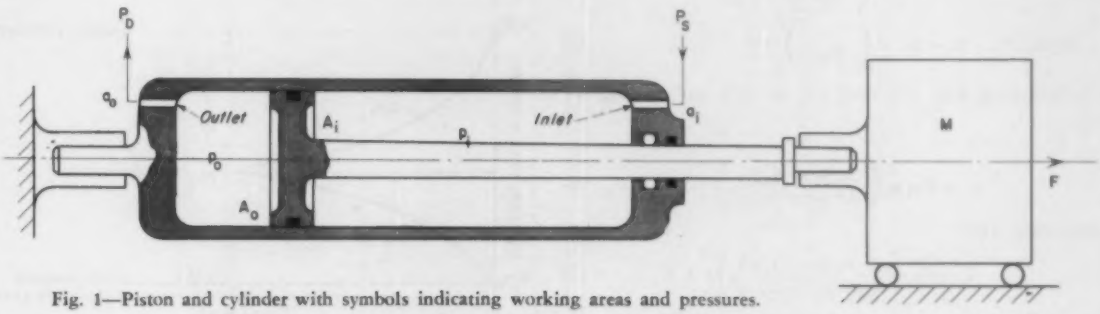


Fig. 1—Piston and cylinder with symbols indicating working areas and pressures.

Transient Response of HYDRAULIC ACTUATORS

E. MUCHA, *Stress Department, Avro Aircraft Ltd., Malton, Ont., Canada*

Formulas for a conventional hydraulic actuator and for simple geometry (the ram moves in a straight line) for these conditions:

1. **zero inertia and zero external load,**
2. **zero inertia and constant external load,**
3. **inertia and constant or variable external loads.**

The equations solve for velocity and piston travel, from which the time for full extension or retraction of the actuator can be calculated. Alternatively, required size of orifices at inlet and outlet may be determined for a reasonable piston speed and required time of operation. An actuator with internal damper is also considered.

THE FOLLOWING ASSUMPTIONS are made in derivation of the main formulas:

(1) Compressibility and mass of the hydraulic fluid are negligible.

(2) Fluid friction losses are negligible.

(3) The flow coefficient is constant and equal to 95.1 $in^2/sec\text{-}lb^{1/2}$. This figure is based on specific gravity of the hydraulic fluid 0.851, and discharge coefficient 0.59.

(4) Mechanical friction in the glands can be taken into account by assuming the efficiency of the actuator $\eta = 0.95$.

Zero inertia and zero load

In this case it is assumed that the moving mass is negligible, external loads are zero, and the flow coefficients for the inlet and outlet ports of the actuator are equal and constant. The flow of fluid through inlet or outlet port is proportional to area and pressure drop. The velocity of the piston is proportional to the rate of flow of the fluid through the ports.

Hydraulic forces on each side of the piston must be in balance, therefore

$$A_i p_i = A_o p_o \tag{1}$$

Where (A_i) and (A_o) are the effective piston areas and (p_i) and (p_o) are the pressures on the inlet and outlet side respectively as shown in Fig. 1.

Rate of flow of the fluid across the inlet valve (q_i) is:

$$q_i = A_i z' = C a_i (p_s - p_i)^{1/2} \tag{2}$$

where (z') is the piston speed, (a_i) the area of the inlet port, and (C) is the coefficient of flow.

Similarly the rate of flow of the fluid across the outlet port (q_o) may be written:

$$q_o = A_o z' = C a_o (p_o - p_d)^{1/2} \tag{3}$$

From (2): $$p_i = p_s - \left(\frac{A_i}{Ca_i}\right)^2 (z')^2 \quad (4)$$

From (3): $$p_o = p_d + \left(\frac{A_o}{Ca_o}\right)^2 (z')^2 \quad (5)$$

Substituting Eqs (2) and (3) in (1) and solving for (z'):

$$z' = Ca_i\, a_o \left(\frac{A_i\, p_s - A_o\, p_d}{A_i^3\, a_o^2 + A_o^3\, a_i^2}\right)^{1/2} \quad (6)$$

Integrating (6):

$$z = Ca_i\, a_o \left(\frac{A_i\, p_s - A_o\, p_d}{A_i^3\, a_o^2 + A_o^3\, a_i^2}\right)^{1/2} t + K \quad (7)$$

where (K) is the constant of integration. When $t = O$, $z = O$, $K = O$.

Let (S) be the total actuator travel and (T) the time in which the actuator is fully retracted, then from (7):

$$T = \frac{S}{Ca_i\, a_o} \left(\frac{A_i^3\, a_o^2 + A_o^3\, a_i^2}{A_i\, p_s - A_o\, p_d}\right)^{1/2} \quad (8)$$

Zero inertia and constant external load

Assuming that when the external load is positive it acts to oppose the inlet side pressure Eq (1) becomes

$$A_i\, p_i - A_o\, p_o = F \quad (9)$$

Eqs (6), (7) and (8) may be written as:

$$z' = Ca_i\, a_o \left(\frac{A_i\, p_s - A_o\, p_d - F}{A_i^3\, a_o^2 + A_o^3\, a_i^2}\right)^{1/2} \quad (10)$$

$$z = Ca_i\, a_o \left(\frac{A_i\, p_s - A_o\, p_d - F}{A_i^3\, a_o^2 + A_o^3\, a_i^2}\right)^{1/2} t \quad (11)$$

$$T = \frac{S}{Ca_i\, a_o} \left(\frac{A_i^3\, a_o^2 + A_o^3\, a_i^2}{A_i\, p_s - A_o\, p_d - F}\right)^{1/2} \quad (12)$$

Inertia and external load

Under inertia and external loads the difference in hydraulic load across the piston is proportional to the acceleration of the moving mass. When pressure is first applied to the cylinder from an external source, pressure on the inlet side of the piston (p_i) rises suddenly to the supply pressure (p_s) and pressure on the outlet side of the piston is equal to the drain pressure (p_d). The hydraulic load causing acceleration of the moving mass supplied by the actuator may be initially assumed: $\eta\ (A_i p_s - A_o p_d)$, where $(\eta = 0.95)$ is the efficiency of the actuator. Under the action of this hydraulic load minus the external load the piston accelerates from rest, and causes pressure on the inlet side of the piston to decrease and pressure on the outlet side of the piston to increase. This is best seen from Eqs (4) and (5). As piston speed increases (p_i) decreases and (p_o) increases as shown in Fig. 2.

Hydraulic load and external forces: $(p_s A_i - p_o A_o - F)$ are balanced by the inertia force. If (M) is the mass in motion, then:

$$Mz'' = p_i\, A_i - p_o\, A_o - F \quad (13)$$

Substituting Eqs (4) and (5) in (13)

$$Mz'' = \eta\,(p_s\, A_i - p_d\, A_o) - F - \left(\frac{A_i^3\, a_o^2 + A_o^3\, a_i^2}{(Ca_i\, a_o)^2}\right)(z')^2 \quad (14)$$

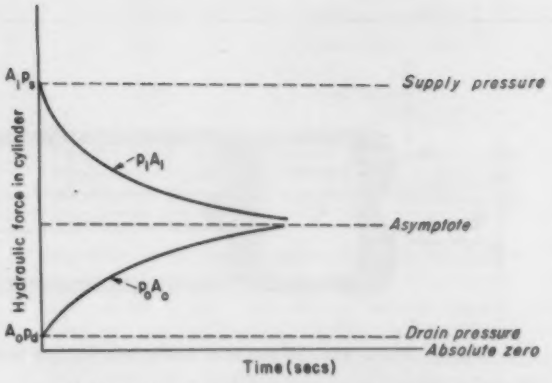


Fig. 2—Hydraulic forces during the transient response of an actuator moving an external mass but without external force.

The piston of the actuator and the mass in motion are accelerated from rest and so initial piston motion is governed by laminar flow through the inlet and outlet ports. Therefore differential Eq (14) is not exact for that period. In derivation of Eq (14) it is assumed that the flow through the inlet and outlet ports is turbulent hence the damping load (third term in Eq 14) is proportional to the velocity squared and the flow coefficient (C) is constant. For laminar flow, the damping force should be proportional to the velocity only, and coefficient of flow through the inlet and outlet valves should vary with the piston speed. For certain velocities of the fluid (certain Reynold's number) the flow is no longer laminar, but not yet turbulent, a transition period, for which the damping is proportional to (V^n), where (V) is the speed of the fluid passing through the ports and n is an exponent between one and two.

In order to approximate the motion of the piston whose speed varies from zero to a certain maximum value, a linear second order differential equation is assumed, and made valid for laminar, transition and turbulent flow by appropriate choice of constants.

$$a\, z'' + b\, z' + d\, z = e \quad (15)$$

The constants (a), (b), (d), (e), are evaluated to match the physical system. The part of Eq (15): $bz' + dz = e$ should give the solution for zero inertia and constant external load. When $(b = T)$, $(d = O)$, $(e = S)$ the physical conditions are fulfilled, as may be checked by substituting Eqs (10) and (12) in this equation. Coefficient (a) in Eq (15) may be determined from the initial conditions:

when

$$t = 0, z = 0, z' = 0, z'' = \frac{\eta\,(p_s\, A_i - p_d\, A_o) - F}{M}$$

Substituting the initial conditions in (15):

$$(a)\ \frac{\eta\,(p_s\, A_i - p_d\, A_o) - F}{M} = S$$

$$a = \frac{MS}{\eta\,(p_s\, A_i - p_d\, A_o) - F}$$

Substituting the coefficients in Eq (15), the differential

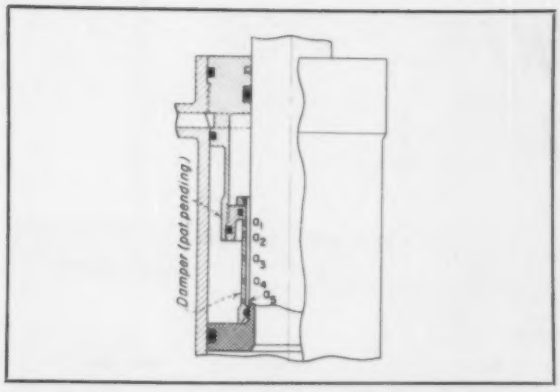


Fig. 3—One method of controlling outlet port area. Near the end of its stroke the piston picks up the movable damper cylinder and successively covers the five outlet orifices.

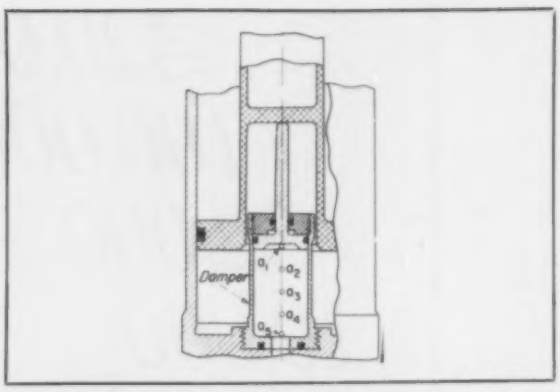


Fig. 4—A design similar in principle to that shown in Fig. 3. Both methods slow the piston at the end of its stroke to avoid mechanical and hydraulic shock at reversal.

equation that approximates the motion of the piston may be written:

$$\frac{MS}{(p_s A_i - p_d A_o) - F} z'' + Tz' - S = 0 \qquad (16)$$

Introducing:

$$\gamma = \frac{MS}{(p_s A_i - p_d A_o) - F} \qquad (17)$$

and dividing (S), Eq (16) becomes:

$$\gamma \frac{z''}{S} + T \frac{z'}{S} - 1 = 0 \qquad (18)$$

The boundary conditions for Eq (19) are: when $t = O$, $z = O$, $z' = O$, and the solution of the differential equation is:

$$\frac{z}{S} = \frac{t}{T} - \frac{\gamma}{T^2}\left(1 - e^{-\frac{T}{\gamma}t}\right) \qquad (19)$$

Differentiating (19):

$$\frac{z'}{S} = \frac{1}{T}\left(1 - e^{-\frac{T}{\gamma}t}\right) \qquad (20)$$

Differentiating (20):

$$\frac{z''}{S} = \frac{1}{\gamma} e^{-\frac{T}{\gamma}t} \qquad (21)$$

Eqs (19), (20), (21) give the travel, velocity and acceleration of the piston. Coefficients (γ) and (T) are given by Eq (17) and modified Eq (12) respectively. Eq (12) should be modified to bring in the efficiency of the actuator thus:

$$T = \frac{S}{Ca_i a_o}\left[\frac{A_i^2 a_o^2 + A_o^2 a_i^2}{\eta (p_s A_i - p_d A_o) - F}\right]^{1/2} \qquad (12)A$$

From Eqs (20) and (21) it is seen that when ($e^{-\frac{T}{\gamma}t}$ is very small,

$$z' = \frac{S}{T} = Ca_i a_o\left[\frac{\eta (p_s A_i - p_d A_o) - F}{A_i^2 a_o^2 + A_o^2 a_i^2}\right]^{1/2} \qquad (22)$$

$$z'' = 0 \qquad (23)$$

Eq (22) points out that there is a certain terminal speed for the piston in a given actuator and that the easiest way to control that speed for given supply and drain pressures and external load is by changing the areas of the inlet and outlet ports.

When the piston reaches a certain velocity, Eq (14) is valid, so it can be used to calculate the terminal velocity of the piston. When ($z'' = O$), Eq (14) becomes:

$$\eta (p_s A_i - p_d A_o) - F - \left[\frac{A_i^2 a_o^2 + A_o^2 a_i^2}{(Ca_i a_o)^2}\right](z')^2 = 0$$

$$z' = Ca_i a_o\left[\frac{\eta (p_s A_i - p_d A_o) - F}{A_i^2 a_o^2 + A_o^2 a_i^2}\right]^{1/2}$$

which is the same as (22) derived from (20). This supports the validity of the linear differential Eq (16).

Speed control

Easiest means to control speed of retraction is by changing the areas of the inlet and outlet ports. When these areas are reduced velocity decreases as shown in Eq (22).

Piston speed at the end of travel is usually of importance. If this speed is high, flow reversal may cause shock waves and high reaction forces on the cylinder. An internal damper should be incorporated in the actuator if high speeds are encountered. Figs. 3 and 4 show internal dampers which reduce the piston speed in four steps having 5 orifices that make the area of the outlet valve: $a_1 + a_2 + a_3 + a_4 + a_5 = a_o$. In Figs. 3 and 4 the orifices are shown on a straight line along the cylinder of the damper; they should be spaced at 72 deg intervals around the circumference of the cylinder. When the piston of the damper progressively covers the orifices, the piston speed of the actuator is slowed. Its numerical value can be calculated using Eq (22) for each step, after the first hole is covered: $a_2 + a_3 + a_4 + a_5 = a_o$, for two holes covered: $a_3 + a_4 + a_5 = a_o$, and so forth.

The geometry and the area of the last orifice a_5 will determine the speed at the end of retraction or extension. The orifice type damper can never reduce the velocity of the piston to zero, but it can bring it down to say 0.5 in./sec which is usually acceptable. •

Statements and opinions expressed in this article are to be understood as individual expressions of the author and not of the company.

1,000,000
320,000
100,000
32,000
10,000
3200
1000
320
100
32
10
3
1

This data-interval number series is simple . . . easy-to-remember . . . useful . . .

FRED W. HOTTENROTH *Cleveland Heights, Ohio*

DATA SHEET — HEAT RUN

Test # 718 Date July 3 1956
Material Tested WHEEL BRAKING - 1441
Input FRICTIONAL - 200 RPM
Ambient Temp. 70°F

TIME SEC.	TEMP. F	TEMP. RISE
0	70	
1		
3.2		
10	79	9
32	97	27
100	133	63
320	165	95
1000	168	98
3200		
10,000		

Test by CNP Approved RS

Fig. 1—Data sheets may be prepared with the time intervals already called out. Undesired readings may be omitted as desired by the experimenter.

What is this set of figures? It is a fast moving series comprised of two numbers, 10 and 32. Zeros are added fore and aft as required to diminish or expand the series.

The doubling series of 1-2-4-8-16 . . . is a well known series. It has been used for "unbeatable" betting schemes and for other not too practical uses. It also has other disadvantages: it requires calculation, it uses fractions below the value of one and it is relatively slow moving.

The 10-32 series is essentially a tripling series. Note in Table I that the doubling series takes 5 steps to advance as far as the 10-32 series does in only 3 steps. Furthermore, the 10-32 series, in 5 steps, advances to 3200 while the doubling series only advances to 320 in the same number of steps. The 10-32 series requires no calculation, is easy to remember and is equally easy to handle in figures below unity as indicated in Table II.

TABLE I—COMPARISON OF 10-32 TO DOUBLING SERIES

Steps	1	2	3	4	5
Doubling	10	20	40	80	160	320
10-32	10	32	100	320	1000	3200

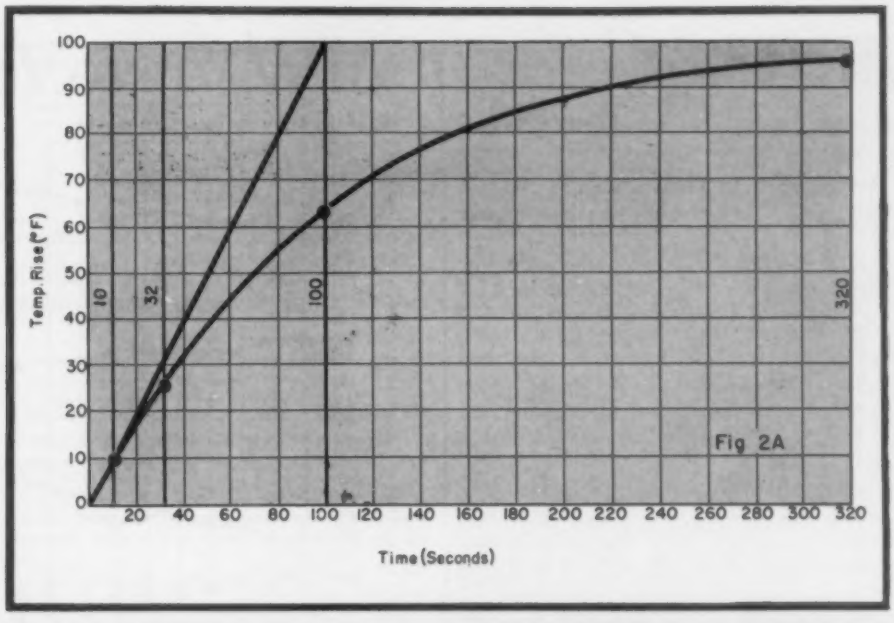
TABLE II—LOW END OF SERIES

0.0010	0.0032	0.010	0.032	0.10	0.32	1.0

A series of this nature is particularly useful in the orderly collection of data in connection with physical phenomena involving logarithmic functions. Temperature rise, atomic decay, light distribution, electric energy, and sound dissipation are all examples of logarithmic functions occurring in nature. The series is also useful whenever time is one of the factors in a physical equation.

In using this series, it is advisable to have pre-printed forms to be filled in with the data. A typical form for a heat rise test is shown in Fig. 1 and it has been filled in with typical readings. The readings could have been taken at arithmetic intervals with readings every few seconds, but the use of the 10-32 series concentrates points on the important parts of the curve and does away with unessential readings on portions of the curve in which changes are slow.

When the curves are plotted from the 10-32 data charts, the spacing of the points is well matched to the curve form. They may be plotted on either linear or semilog paper. In either case it is advisable to use paper prepared in advance by adding markings at the 10 and 32 locations.



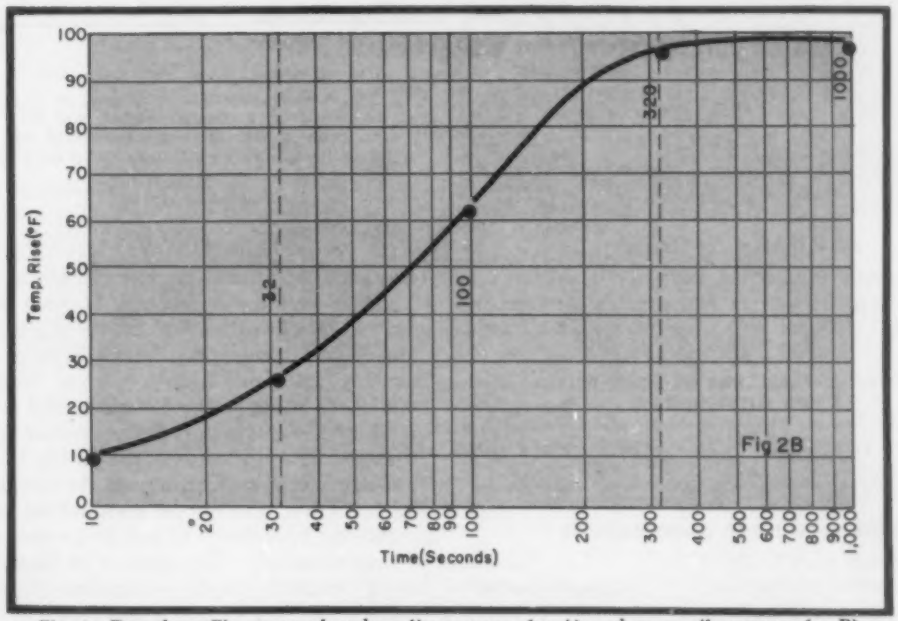


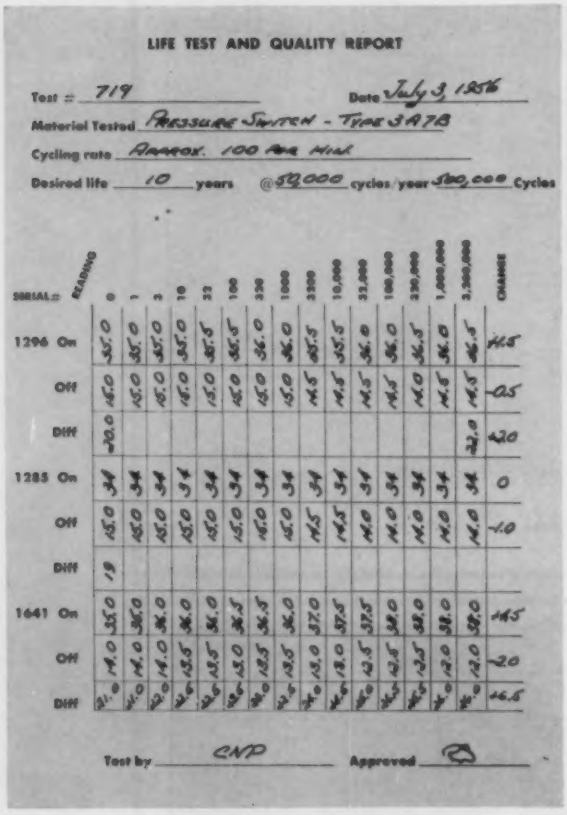
Fig. 2—Data from Fig. 1 are plotted on linear paper (at A) and on semilog paper (at B).

At (A) of Fig. 2 a typical heat rise curve is plotted on linear paper. More readings have been taken at the early part of the curve where changes are taking place rapidly and less frequent readings are taken where changes are more gradual.

At (B) of Fig. 2 the same data are plotted on semilog paper. This plot has the advantage of expanding the early part of the curve so that more accurate values may be read from this part of the curve. It also shows the even spacing of points along the horizontal axis when data taken on the 10-32 basis is plotted on semilog or log-log paper.

This series is particularly advantageous for life test data and curves. A device on life test will generally have the fastest rate of change during the early part of the test. During this period it is desirable to take readings at close intervals. In the later stages of the test, the intervals can be spaced further apart. The tolerance on life predictions and change predictions is generally a percentage of the value itself. This agrees mathematically with accumulation of data in logarithmic increments in accordance with the 10-32 series, so the use of the 10-32 series in taking readings, automatically spaces the readings at suitable intervals. A typical test data form is shown in Fig. 3 and curves are plotted from the data.

Many standardization programs are based upon the Preferred Number Series approved by the American Standards Association. This is a slow moving series. The



LIFE TEST AND QUALITY REPORT

Test # 719 Date July 3, 1956

Material Tested PRESSURE SWITCH - TYPE 3A7B

Cycling rate APPROX. 100 PER MIN

Desired life 10 years @ 50,000 cycles/year 500,000 Cycles

SERIAL #	READING	0	1	3	10	32	100	320	1000	3200	10,000	32,000	100,000	320,000	1,000,000	3,200,000	CHANGE
1296	On	35.0	35.0	35.0	35.0	35.5	35.5	36.0	36.0	35.5	35.5	36.0	36.0	36.5	36.0	36.5	+1.5
	Off	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.5	14.5	14.5	14.5	14.5	14.0	14.5	14.5	-0.5
	Diff	20.0														22.0	+2.0
1285	On	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	0
	Off	15.0	15.0	15.0	15.0	15.0	16.0	15.0	14.5	14.5	14.0	14.0	14.0	14.0	14.0	14.0	-1.0
	Diff	19															
1641	On	35.0	36.0	36.0	36.0	36.0	36.5	36.5	36.0	37.0	37.5	37.5	38.0	38.0	38.0	38.0	+1.5
	Off	14.0	14.0	14.0	13.5	13.5	13.0	13.5	13.5	13.0	12.0	12.5	12.5	12.5	12.0	12.0	-2.0
	Diff	21.0	22.0	22.0	22.5	22.5	23.5	23.0	22.5	24.0	25.5	25.0	25.5	25.5	26.0	26.0	+4.5

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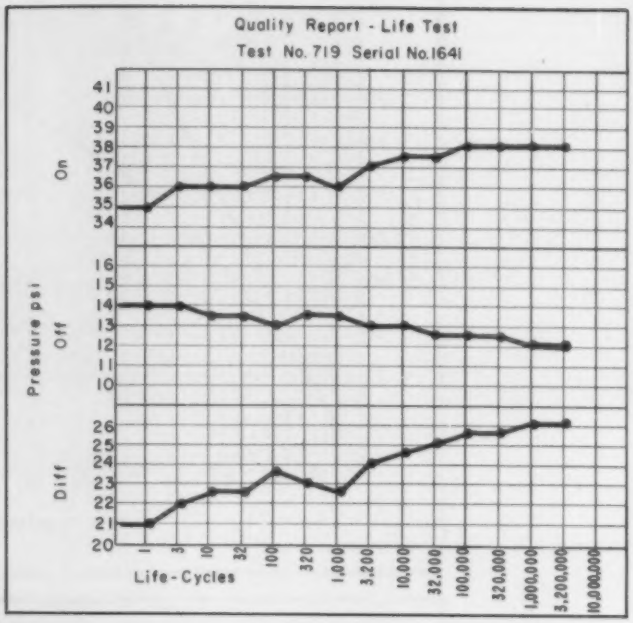


Fig. 3—Life test data form used to record pressure at actuation of a pressure switch and plot of data as a function of life. Note that horizontal axis of the plot is logarithmic though the coordinates are equally spaced.

Primary numbers advance in steps of 60 per cent in comparison with the 100 per cent steps of the Doubling series and the 220 per cent steps of the 10-32 series.

TABLE III—A.S.A. PREFERRED NUMBERS WITH 10-32 SERIES SUPERIMPOSED

Primary	10	16	25	40	63	100
Secondary	13.5	20	32	50	80	

TABLE IV—NUMBER COMBINATIONS

Exact		Approx. Round Numbers		Closest Preferred Numbers	
1	3.16	1	3	10	32
2	6.32	2	6	20	63
3	9.48	3	10	32	10
4	12.64	4	13	40	125
5	15.80	5	16	5	16
6	18.96	6	19	20	63
7	22.12	7	22	none	
8	25.28	8	25	8	25
9	28.44	9	28	none	

There are standardization programs in which it is desirable, at least in starting the program, to use a faster moving series and thereby reduce the quantity of numbers selected.

In Table III note that the 10-32 series can be considered a series within the Preferred Numbers Series. Both 10 and 32 are Preferred Numbers and they are evenly spaced at 5 steps in the Preferred Number series. A Standardization program initiated on the 10-32 basis can be coordinated at a later date with the complete Preferred Number series. During the coordinating period it may simplify the transition if 16 and 63 are next added to the 10-32 combination. The result is an intermediate series having relatively smooth increments approaching the Preferred Numbers series as a final goal.

Why These Numbers?

Any set of numbers having a multiplier approximately equal to the square root of ten can be used for a series of this nature. Table IV shows various combinations which could be considered. From a practical viewpoint, combinations seven and nine can be dropped from consideration because they have no representation on the Preferred Number series. Combination four with 40-125 is not particularly simple and has more digits than necessary. This narrows the selection to 5-16, 10-32 and 20-63. These numbers are similar but the 20-63 seems more complicated than either of the others and the 10-32 series with unity as part of the series has slight advantages over the 5-16 series for plotting purposes and calculation. For this reason the 10-32 combination is given preference. ●

Woven-Wire Conveyor Belts

J. F. REID
Manager, Belt Division, The Cambridge Wire Cloth Co., Cambridge, Md.

Applications, materials, weaves, reinforcing, selvages and cleats, guides and supports, drive and power requirements, all are included in this summation.

Conveyor type required to move work continuously through a machine depends on severity of service conditions including temperature, corrosion, abrasion, wet and humid atmosphere, and on need for free passage of fluids or small solid particles through the belt. Belts may be of fabric, rubber, leather, segmented metal track or woven wire. Variables involved in a woven wire belt are wire materials, weave, cleats and selvages, belt drive and supports, power and tension requirements.

Generally speaking, wire belts can be constructed of any material that can be drawn into wire. Wire size is based on strength requirements, and wire material on temperature and other service conditions (Table I).

For temperatures up to 400 F galvanized low-carbon steel wire is designed to meet moist and slightly corrosive conditions. Tinned low-carbon steel finds limited application in food processing.

Up to 500 F plain low-carbon steel, electrolytic tough pitch copper and phosphor bronze give good service, choice depending on conditions. In the glass industry aluminum gives good results up to 700 F. High carbon and high creep

TABLE 1—CHARACTERISTICS OF CONVEYOR BELT MATERIALS

Material	Temperature, F	Environment	Special Properties
Carbon Steel			
Low (0.10 to 0.12) Carbon	to 500	Dry, non-corrosive	
Galvanized	to 400	Moist, low corrosion	
Tinned	to 400	Foods. Humidity	
High (0.40 to 0.50) Carbon	to 1000	Dry	Brittle at welds
HC	to 1000	Dry	High creep
Low-Alloy, Molybdenum Stabilized Steel			
1 Cr	to 1200	Oxidizing, mild	
2 Cr	to 1250	Oxidizing, medium	
3 Cr	to 1300	Oxidizing, med-severe	
4 Cr	to 1400	Oxidizing, severe	
Stainless Steel			
12 Cr	1000 to 1200	Corrosive	Good creep strength
17 Cr	1100 to 1300	Corrosive	Oxidation resistant
25 Cr-12 Ni	1200 to 1600	Corrosive	High strength
25 Cr-20 Ni	1400 to 2100	Corrosive	Wide thermal range
Nickel-Base Alloys			
Monel	to 700	Corrosive	High strength
Inconel	1470 to 2050	Oxidizing, S	
35 Ni-19 Cr	1800 to 2050	Corrosive, Low S	
80 Ni-20 Cr	1800 to 2100	Corrosive, Low S	
Special Wires			
Aluminized Steel	up to 1200	Sulphur and carbon gases	
Electrolytic Tough Pitch Copper	up to 500	Corrosive	
Phosphor Bronze	up to 500	Depends on composition	Abrasion resistance
Aluminum	up to 700	Non-corrosive	High yield and tensile strength. Good cold working properties.

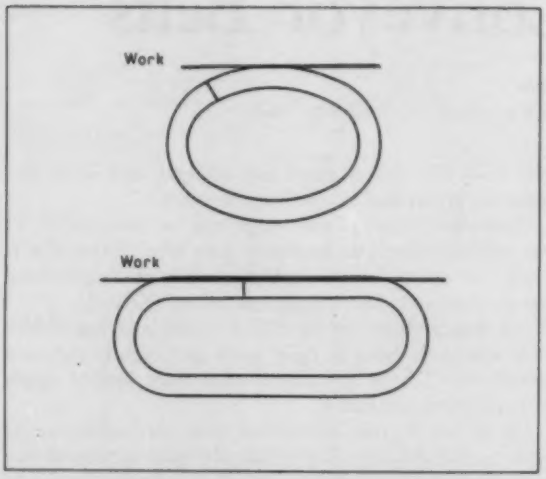


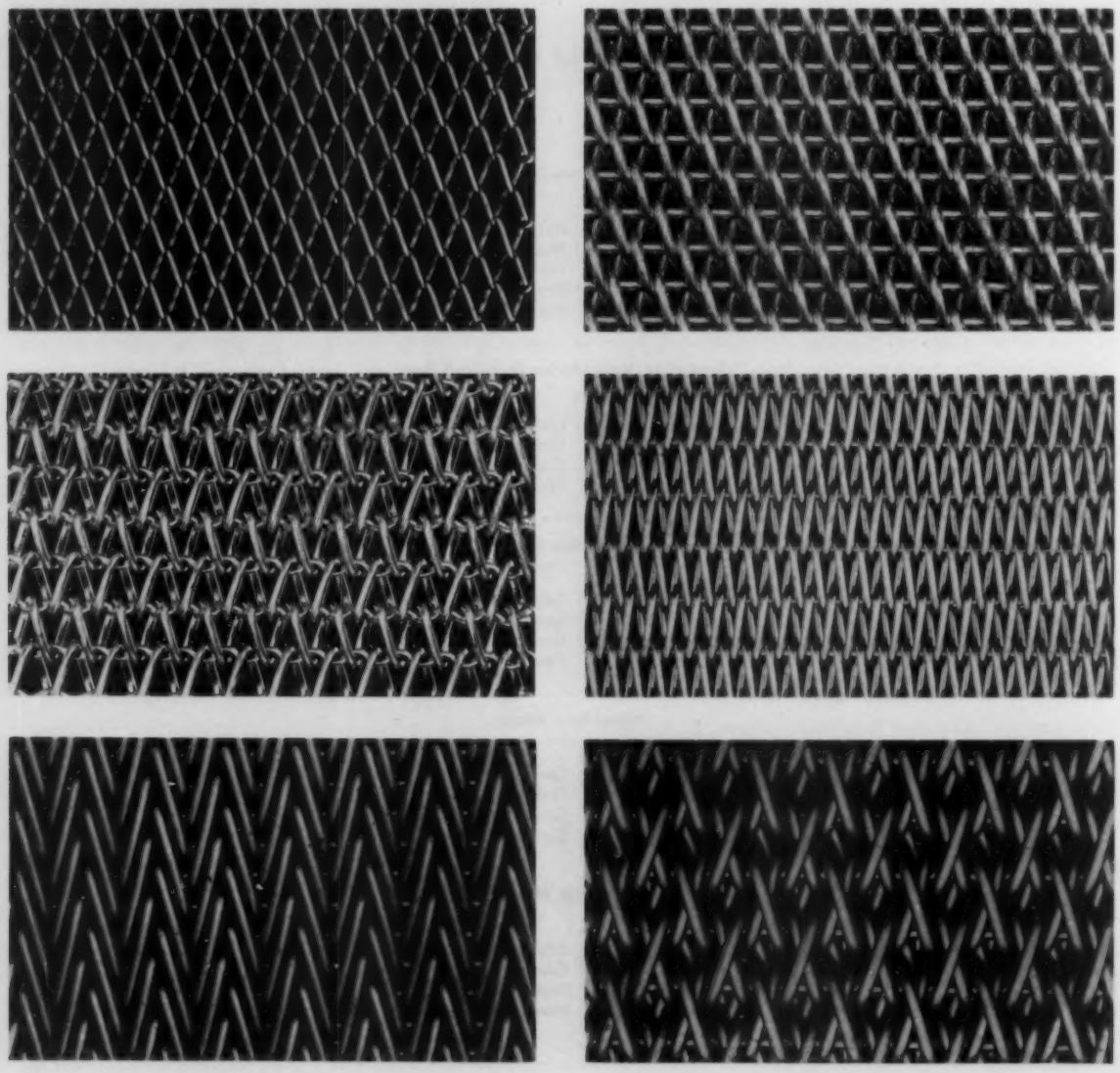
Fig. 1—End view of spirals used in wire belt construction. Oval spiral, left, has only point contact with work; flat spiral, right, has line contact.

steels offer good resistance to temperatures up to 1000 F. Up to 1200 F Aluminized steel resists attack from sulphur and carbon gases.

Between 1200 and 1400 F molybdenum-stabilized low-alloy steels find special applications in oxidizing atmospheres, with more severe conditions calling for alloys with higher chromium content.

Stainless steels and nickel-base alloys combine resistance to corrosion with long life at high temperatures, but they work best within narrow temperature limits. Monel is not recommended for high temperature application.

The fundamental unit of any woven-wire belt is a spiral, which in practice is either oval or flat, Fig. 1. Of the



two, the flat spiral offers the larger bearing surface and does not easily tip over parts carried by it. Process of forming this spiral, however, causes tool marks and stress concentrations which are potential source of fatigue failure, while the shape of the spiral does not promote good hinging action. On the other hand, the oval spiral has a more even distribution of stresses and a better hinging capacity, at the expense of smoothness of belt surface.

The spiral may be wound either right- or left-hand. The basic weave is a series of interwoven spirals, all wound in the same direction. But a unidirectionally wound belt would soon "walk off" its rotating supports, so sections of right-hand wound spirals are alternated with sections of left-hand wound ones (sectional construction), or the spirals are hinged on wires or rods. In some instances both alternate hand winding and interposition of rods are used. Constructions shown in Fig. 2 are representative.

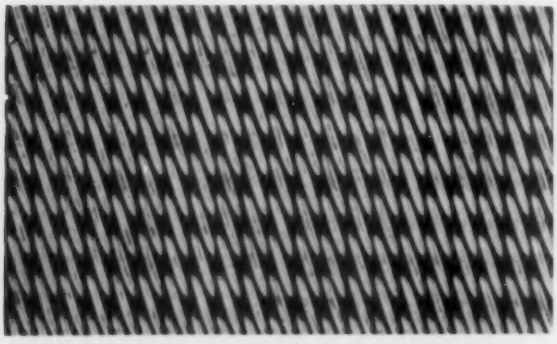
Strength of belt is determined by actual test. It is preferable to obtain increased strength by going to a construction having more wires per unit area rather than by increasing the size of the wire, unless openness of mesh is a desired characteristic.

When needed, the conveyor belt can be provided with retaining selvages to keep the live load from falling off. A variety of such selvages have been developed to meet varying operating conditions.

Just as the selvages keep the parts from falling off the sides, cleats prevent slippage along the belt. Cleat design is based on size and shape of the live load, and by the angle the loaded belt makes with the horizontal.

All other conditions being the same, belt life is increased by reducing strain in operation. This is achieved by increasing the contact surface between belt and pulley with drive pulleys of large diameter and by increasing the arc of contact between pulley and belt, Fig. 3. Under special conditions the arc of contact may be increased by the double drive pulley.

As a general rule, drive pulley is at the discharge end



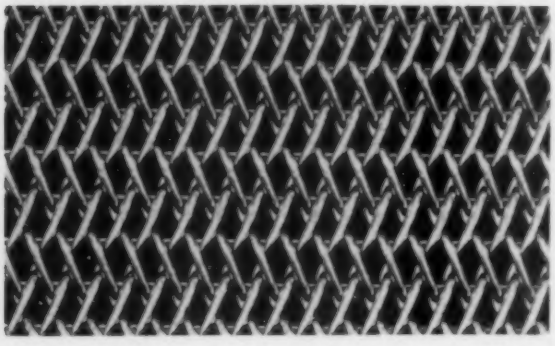
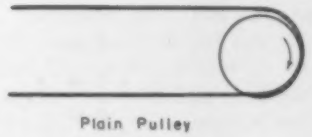
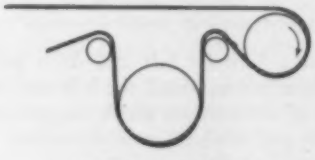
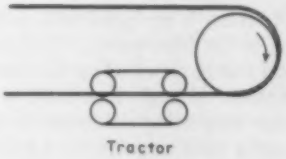
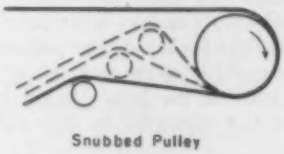


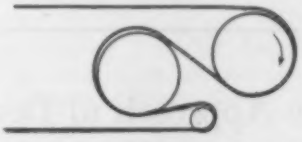
Fig. 2—Conveyor belt weaves. Top row: all wound in one direction. Middle row: three ways of balancing right- and left-hand wound spirals. Bottom row: multiple weaves.











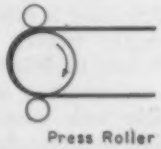


Fig. 3—Drives for wire belts.

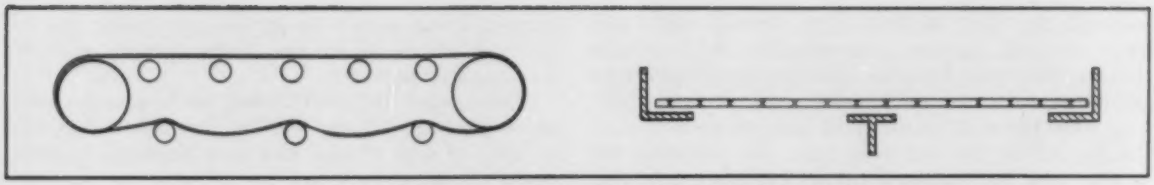


Fig. 4—Wire-belt supports: roller type at left, slider-bed type at right.

of the conveyor, but in installations where the belt operates at high temperatures, belt life is prolonged by placing the drive pulley at the charging or cold end. In such cases, rollers press the belt onto the driving pulley to maintain a large enough arc of contact.

TABLE II—COEFFICIENTS OF FRICTION SLIDE BED CONVEYORS

Temperature, F	Metal	Brick
up to 1000	0.35	0.50
1200	0.37	0.52
1400	0.40	0.54
1600	0.44	0.57
1800	0.49	0.60
2000	0.55	0.65

Where friction between belt and drive pulley is not adequate to move belt and load, the belt can be equipped with a variety of drive chains which engage sprockets on the drive pulley and receive a positive motion.

Guides and Supports

The slack belt return is equipped with guides to assure straight approach to the idler pulley. Guides may be simple sets of vertical rollers mounted on the conveyor frame, or they may be strips of angle iron built integrally with the frame. Where supporting rollers are used, these may be flanged to form a positive guide for the belt.

The type of support a belt needs varies with the length of the belt and the types of load it handles, Fig. 4. Short belts that handle light loads can have stationary supports, which consist of angle irons on each side and supporting "tees" for the body of the belt. Longer belts carrying heavier loads are best supported by idler rollers installed to support the belt across its entire width. Spacing of supports is dependent on the type of installation, being as little as 6 in. in some and as much as 6 ft. in others.

Horsepower

Important in design are the horsepower required to move belt and load at the desired speed, and the tension differential which must be maintained between the tight and the slack sides of the belt to keep desired speed.

Pulling force required is equal to the force necessary to overcome friction, plus the force needed to elevate the load. These forces may be calculated separately, then added to obtain the total pull required. Friction coefficients are a function of the type of support employed. In the case of an all-roller support, if the rollers run in ball bearings, the coefficient of friction is 0.05, if in sleeve bearings it is 0.10. If part of the belt is supported by slide beds, the coefficient of friction for the part of the belt and load so supported is taken from Table II.

With belt speed known, the nominal horsepower required is calculated from the standard horsepower equation. Actual motor horsepower required at the drive pulley is obtained by dividing nominal horsepower by overall efficiency of transmission. Factors affecting efficiency of transmission are losses inherent in single- and double-worm reducers, gear-and-chain drives, and slip between belt and drive pulley.

To drive a conveyor belt, a tension differential is needed between the tight and the slack sides of the belt at the drive pulley, this differential being equal to the total pull. Ratio of the two tensions is a function of the amount of belt wrap on the driving pulley and of the coefficient of friction between belt and pulley.

Disadvantages of the woven wire belt are its tendency to stretch, necessitating periodic check and take-up and the small area of contact with the drive pulley, resulting in a tendency to slip unless special provisions are made. Such provisions, including drive chains and double drive pulleys, increase original cost and cost of operation. ●

New Approach to Design Thinking

Responsibility assigned to engineering design today is extending far beyond merely meeting performance. Products must be designed for specific market requirements; cost must be compatible with value, and design compatible with manufacturing methods. Automatic manufacture and assembly adds a new dimension, making the designer responsible for both the product and the machine to make it. Add to this the increased complexity involved in materials selection, production methods and the need to make products more automatic. The result is a changing approach to design thinking.

A special report in the May issue will examine this signficant development, and report the varied experience of several companies in meeting this growing problem. Articles will discuss policies, procedures and accomplishments in some detail. ●

Second Design Show Doubles in Size

NEW YORK CITY will be the site of the Second Design Engineering Show and Conference on May 20-23. Only in its second year, the Show arranged primarily for design engineers, has jumped to among the top five of the annual industrial expositions. Last year there were 172 exhibitors; to date 375 are scheduled to exhibit in this year's show. Next year the show will be held in Chicago.

Thirty-three speakers will take part in the Design Engineering Conference. The program is set up as follows:

May 20—Panel Session.

"Procedures in Developing New Designs," a panel session with questions from the floor. Chairman and moderator: George F. Nordenholt, Editor, *Product Engineering* magazine. Vice chairman: Charles Marks, member, New York Patent Bar.

Panel Members: T. M. Butler, director of engineering, Burroughs Corp., Detroit, Mich.; Myron S. Curtis, engineering vice president, Warner & Swasey Co., Cleveland, Ohio; George F. Habach, vice president, engineering, Worthington Corp., Harrison, N. J.; Robert H. Hose, partner, Henry Dreyfus Associates, New York; William J. Russell, vice president, engineering, Landers, Frary & Clark, New Britain, Conn.; and Walter Darwin Teague, Walter Darwin Teague Associates, New York.

May 21—Three Concurrent Sessions.

Mechanical. Chairman: Colin Carmichael, Editor, Machine Design, Cleveland. Vice chairman: Robert M. Conklin, assistant manager, mechanical engineering department, Battelle Memorial Institute, Columbus, Ohio. Two papers will be presented:

"New Developments in Design and Application of Gearing," by Darle W. Dudley, advanced design engineer, gear engineering, General Electric Co., West Lynn, Mass.

"New Developments in Design and Application of Cams," by Harold A. Rothbart, professor, department of mechanical engineering, City College of New York, N. Y.

Materials Session. Chairman: Henry R. Clauser, Editor, Materials & Methods, New York. Vice chairman: Joseph Bonanno, chief engineer, Lionel Corp., Irvington, N. J. This session will also have two papers:

"Metallic Materials," by C. R. Simcoe, principal metallurgical engineer, Battelle Memorial Institute, Columbus, Ohio.

"Ceramics and Refractory Materials," by John H. Koenig, director, and Edward J. Smoke, professor, School of Ceramics, Rutgers University, New Brunswick, N. J.

Electrical Session. Chairman: Frank J. Oliver, Editor, Electrical Manufacturing, New York. Vice chairman: Walter T. Buhl, vice president, engineering and manufacturing, Leland Electric Co., Div. American Machine & Foundry Co., Dayton, Ohio. The two papers are:

"Selecting Motors with New NEMA Frame Sizes," by Earl Barnes, assistant chief engineer, Reliance Electric & Engineering Co., Cleveland, Ohio.

"Static Switching Devices," by Dr. Robert A. Mathias, assistant professor, department of electrical engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

May 22—Three Concurrent Sessions.

Mechanical Session. Chairman: Harold Sizer, director of design for machine tools, Brown & Sharpe Manufacturing Co., Providence, R. I. Vice chairman: William C. Allen, director, manufacturing and equipment engineering, Westinghouse Electric Co., Pittsburgh, Pa.

"Designing for Easier Machining, Handling and Assembly," by Kurt O. Tech, vice president in charge of engineering, Cross Co., Detroit, Mich.

"Hopper Feeding," Floyd E. Smith, president, Perry Equipment & Engineering Co., Erie, Pa.

Materials Session. Chairman: Carl Massopust, director of research and development, plastics division, General American Transportation Corp., Chicago, Ill. Vice chairman: Donald R. Meserve, products manager, organic coatings, Metal & Thermit Corp., New York.

"Plastics and Rubbers," by Wyman Goss, manager, phenolics engineering, chemical materials department, General Electric Co., Pittsfield, Mass.

"Coatings and Finishes," by H. J. Reindl, supervisor, research and development, finishes section, Inland Manufacturing Division, General Motors Corp., Detroit, Mich.

Electrical Session. Chairman: Dr. Cuthbert C. Hurd, director of automation research, International Business Machines Co., New York. Vice chairman: John Randall, assistant director, manufacturing engineering office, Ford Motor Co., Dearborn, Mich.

"Numerical Control for Machinery," by Claude D. Coffin, senior electrical engineer, Warner & Swasey Co., Cleveland, Ohio.

"Designing Machine Tools for Automatic Controls," by C. B. Sung, manager, mechanical development section, research laboratories division, Bendix Aviation Corp., Detroit, Mich.

The May issue of *Product Engineering* will include full abstracts for each of the papers and further information about the technical program. A special section of this issue will also review significant new products at the Show.

Step-by-step computations for epicyclic gear trains gives forces and speeds without using hard-to-remember formulas, for compound as well as simple trains.

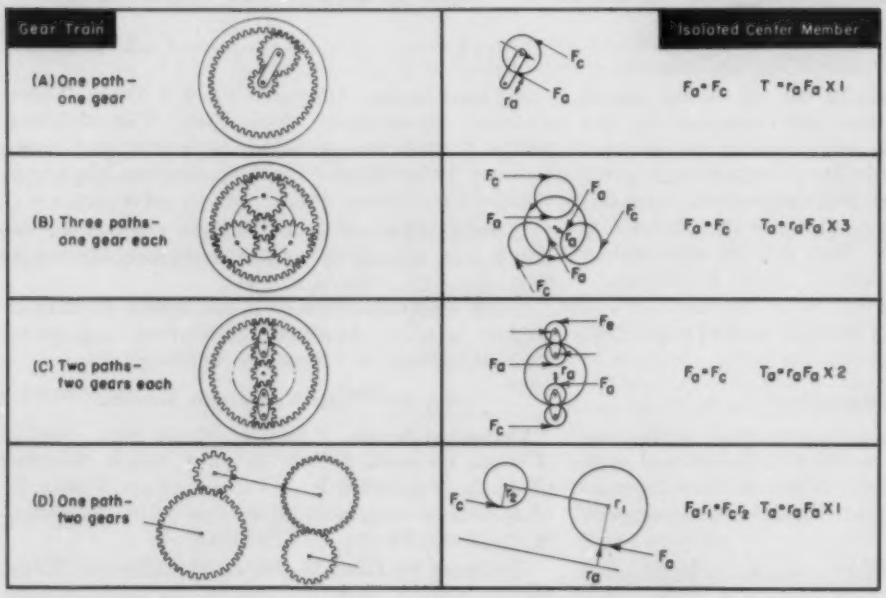

Gear Train
Isolated Center Member
(A) One path – one gear
$F_a = F_c$
$T = r_a F_a \times 1$
(B) Three paths – one gear each
$F_a = F_c$
$T_a = r_a F_a \times 3$
(C) Two paths – two gears each
$F_a = F_c$
$T_a = r_a F_a \times 2$
(D) One path – two gears
$F_a r_1 = F_c r_2$
$T_a = r_a F_a \times 1$

Fig. 1—In this design method centre members are first isolated and their force diagrams drawn. Four typical epicyclic gear trains most often used are here analyzed. This method provides quick and simple solution of gear train problems, based on summation-of-energy equations.

New Approach Cuts Work in . . .

EPICYCLIC GEAR

In problems involving epicyclic gear train calculations many involved methods have been and are being used to find forces and speeds. Reducing an epicyclic train to its component parts and analyzing the center member provides a quick and easy method for the solution of these problems.

An epicyclic gear train at constant velocity can be compared to a balanced lever. The three torques of the train, consisting of two end member torques and center member torque, must balance as do three forces acting on a lever.

To solve torque and force balance of an epicyclic gear train, any one of the torque values together with the physcial measurements of the train are all that need to be known. It is assumed that the train is in equilibrium and at rest. In the plane of rotation there will be two forces for each gear path which act on the rotating arm at points where the arm contacts the two end members. As shown in Fig. 1. these two forces act on the isolated center members at the pitch circles of gears involved. By analyzing one gear path the relationship between these two forces can be formed. T_a and T_c can be found by multiplying F_a and F_c by their acting radii and the number of parallel gear paths. T_b can be found by adding T_a and T_c since the train is in equilibrium.

So far speeds have not been needed or used in the calculations. In a simple train if the speed of any two members is known, the speed of the third member may be found from

$$\pm T_a N_a/5250 \pm T_b N_b/5250 \pm T_c N_c/5250 = 0$$

which reduces to

$$\pm T_a N_a \pm T_b N_b \pm T_c N_c = 0$$

This is a summation-of-energy equation with three terms representing horsepower input or output at the three members of the train. No friction or energy losses need be accounted for in these theoretical calculations. When using this equation only one sign convention must be remembered: **If a member rotates in the same direction as external torque applied to train then the energy term must have a positive sign. This represents added horsepower. If rotation and torque direction are opposite the sign will be minus.**

Sample problem.

In typical epicyclic gear train illustrated in Fig. 1(b),

1. Sun gear (member a) has 2 in. pitch diameter; 3000 rpm, torque-100 in./lb
2. Planet gears (member b) have 3 in. pitch diameter.

Symbols

F_a, F_c = forces on center member
T_a, T_c = torques on two end members
T_b = torque on center member
N = speed in rpm
r_a, r_c = radii at which forces F_a, F_c act.

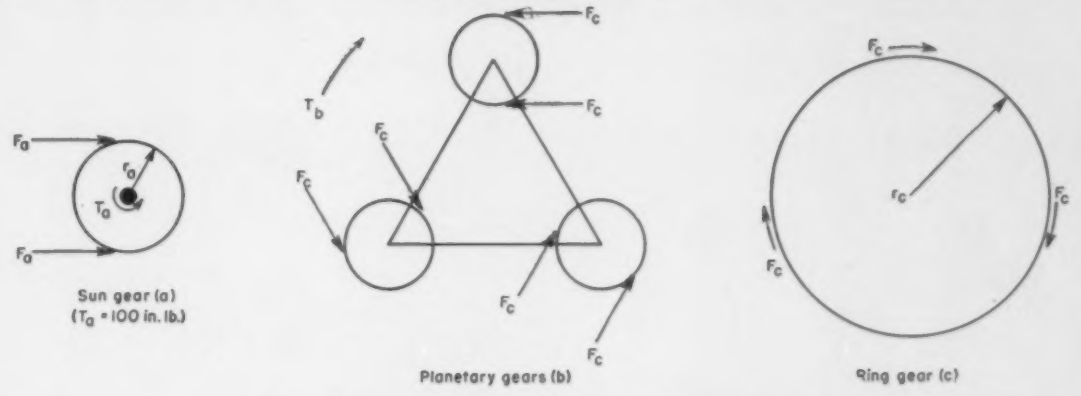


Fig. 2—First step in sample problem is to isolate the component parts of gear train and draw force diagrams for all three members.

TRAIN Calculations

R. M. CONKLIN
and
JAMES BALLMER
Battelle Memorial Institute

3. Ring gear (member c) has 8 in. pitch dia; 400 rpm

Find (1) ring gear torque; (2) center member torque; (3) center member speed:

1. Isolate and sketch center member and end members as in Fig. 2.

2. Write radius-force-torque formulas and find tooth forces

$$T_c = 3r_cF_c$$
$$F_c = F_a$$
$$3F_ar_a = 100 \text{ in-lb.}$$
$$F_a = 100/3(1) = 33\ 1/3 \text{ lb.}$$
$$T_c = 3(4)33\ 1/3 = 400 \text{ in-lb}$$

3. Take moments about center of rotation of center member to find center member torque.

$$T_b = (2F_c)\ (3)\ (2.5) = 2(100/3)\ (3)\ (2.5) = 500 \text{ in-lb}$$

4. All torques and tooth forces are now known. Use summation-of-energy equation to find center member speeds and horsepower. (Note positive or negative sign by energy convention.)

$$+ T_aN_a - T_bN_b + T_cN_c = 0$$
$$(100)\ (3000) - 500N_b + (400)\ (400) = 0$$
$$N_b = 920 \text{ rpm}$$

It is thus seen that solution of this type of epicyclic gear train problem is easily obtained by use of this simplified method of treatment.

EDITOR'S NOTE—Further information concerning planetary gearing can be found in the following articles: "Stress Cycles in Planetary Gears," January 1957 page 219, tabulates formulas for finding number of stress cycles a gear's tooth receives during its life. "General Equations for Solving All Planetary Gear Ratios", 4th Product Design Digest Issue, page E12a. Solutions for all gear train arrangements are derived from one basic general equation. "Whole Number Solutions of Indeterminate Equations for Gearing", May 1954 page 198, shows how a method of Diophantine equations can be applied to the solution of gear problems involving indeterminate equations. Method applies especially to planetary gearing. "Formula for Epicyclic Gear Train of Large Reduction", December 1954 page 213.

Important information on gearing also appears in. "Wear Life of Aluminum Gears", September 1956 page 160. An analytical procedure is given for estimating the probable life of aluminum gears. "Methods of Specifying Precision of Spur Gears", November 1956 page 135, includes methods of making measurements and converting AGMA and modified AGMA systems one to another. "Effect of Gear Size on Gear Design Calculations", Apr. 1954 page 129.

Gear-Shift Arrangements

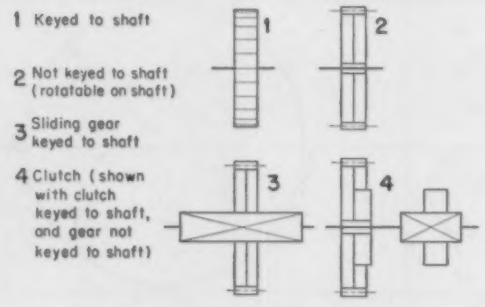

1 Keyed to shaft
2 Not keyed to shaft (rotatable on shaft)
3 Sliding gear keyed to shaft
4 Clutch (shown with clutch keyed to shaft, and gear not keyed to shaft)
1
2
3
4

Fig. 1. Schematic symbols used in the illustrations to represent gears and clutches.

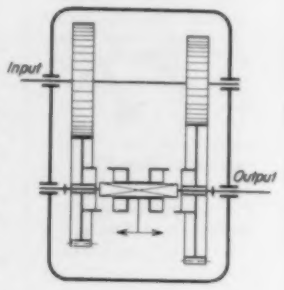
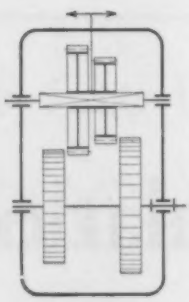


Fig. 2. Double-clutch drive. Two pairs of gears permanently in mesh. Pair I or II transmits motion to output shaft depending on position of coupling; other pair idles. Coupling shown in neutral position with both gear pairs idle. Herring-bone gears recommended for quiet running.

Fig. 3. Sliding-change drive. Gears meshed by lateral sliding. Up to three gears can be mounted on sliding sleeve. Only one pair in mesh in any operating position. Drive simpler, cheaper and more extensively used than drive of Fig. 2. Chamfering side of teeth facilitates engagement.



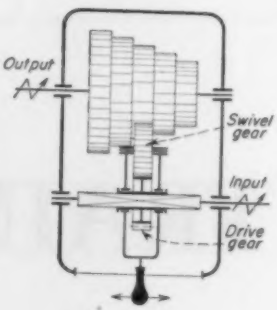


Fig. 4. Swivel-gear drive. Output gears are fastened to shaft. Handle is pushed down, then shifted laterally to obtain transmission through any output gear. Not suitable for transmission of large torques because swivel gear tends to vibrate. Over-all ratio should not exceed 1:3.

Fig. 5. Slide-key drive. Spring-loaded slide key rides inside hollow output shaft. Slide key snaps out of shaft when in position to lock a specific change gear to output shaft. No central position is shown.

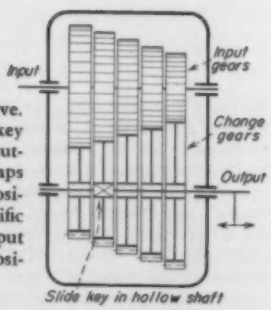


Fig. 6. Combination coupling and slide gears. Three ratios: direct mesh for ratios I and II; third ratio transmitted through gears II and III which couple together.

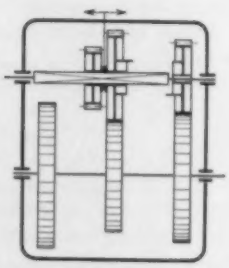
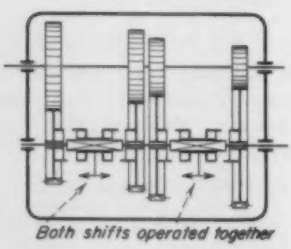


Fig. 7. Double-shift drive. One shift must always be in a neutral position which may require both levers to be shifted when making a change. However only two shafts are used to achieve four ratios.



SIGMUND RAPPAPORT

Project Supervisor, Ford Instrument Company
Adjunct Professor of Kinematics
Polytechnic Institute of Brooklyn

13 ways of arranging gears and clutches to obtain changes in speed ratios.

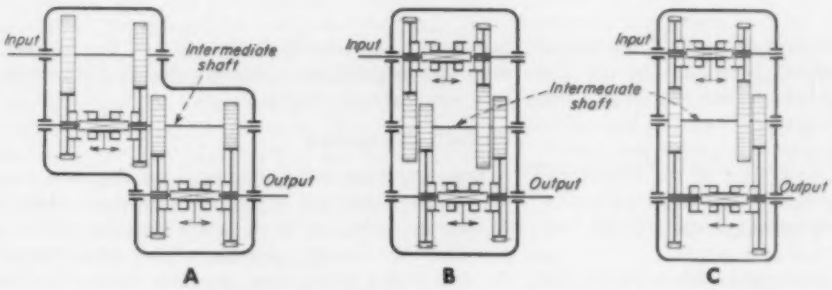


Fig. 8. (A) Triple shaft drive gives four ratios. Output of first drive serves as input for second. Presence of intermediate shaft obviates necessity for always insuring that one shift is in neutral position. Wrong shift lever position can not cause damage. (B) Space-saving modification. Coupling is on shaft *A* instead of intermediate shaft. (C) Still more space saved if one gear replaces a pair on intermediate shaft. Ratios can be calculated to allow this.

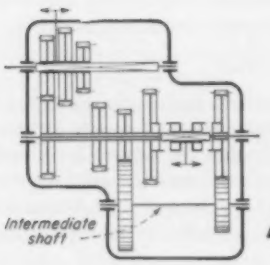
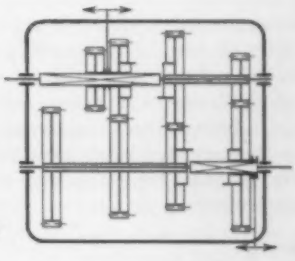


Fig. 9. Six ratios available with two couplings and (A) ten gears, (B) eight gears. Up to six gears in permanent mesh. It is not necessary to insure that one shift is in neutral.



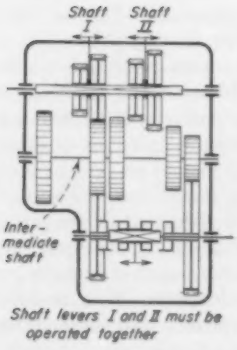


Fig. 10. Eight-ratio drive uses two slide gears and a coupling. This arrangement reduces number of parts and meshes. Position of shifts I and II are interdependent. One shift must be in neutral if other is in mesh.

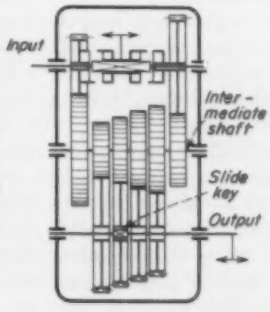


Fig. 11. Eight ratios; coupled gear drive and slide-key drive in series. Comparatively low strength of slide key limits drive to small torque.

Data based on material and sketches in AWF und VDMA Getrieblaetter, published by Ausschuss fuer Getriebe beim Ausschuss fuer Wirtschaftiche Fertigung, Leipzig, Germany.

The Administrative Engineer . . . . . CAN help

PILSON W. KELLY, M.E., C.P.A.
Treasury Services Supervisor
Ford Instrument Co.

How he smoothes the path for researcher, designer and manager by supplying planning and control.

ENGINEERING is sometimes defined as "the direction of the forces and materials of nature to the use and convenience of man," and administer has the literal Latin meaning of "to serve." In its acquired meaning the service is essentially some form of guidance toward a goal, usually a two-phase non-conflicting goal, such as the expeditious making of products with a profit. Thus Administrative Engineering seems to be an organized guidance of the business end of engineering.

Even in a business in which each day is much like another, a surprising amount of administration is required. Operation of an electric generating station, a typewriter factory or a steel mill cannot be left entirely to standard procedures despite the fact that men have had 50 years to make mistakes, find workable ways of doing things, and weave them into standard methods and systems. Therefore, it is easy to see why Administrative Engineering is particularly important in the uncertainties of successful military manufacture with which this article is primarily concerned. After all, our history includes little more than 10 years of all-out military production.

One way of illustrating the nature, mechanisms and potentialities of Administrative Engineering is by specific examples. The few presented below are selected to provide some perspective by using two viewpoints, that of Government and management.

Contract Digests

There are two extreme schools of thought on the method of determining the requirements of a contract. Neither of them is good, but clear, workable systems are being used which are compromises of these extremes.

The first extreme uses no digest, though it may have a sheet listing the contract date, the formalized supplemental agreements, with date and possibly contract price. This system is inadequate since unformalized changes, letters and the like are not readily available in digest form. To find out anything about the contract, all the fine print must be read and all the correspondence reviewed.

The other extreme consists of issuing a company supplement every time a change of any kind occurs, with new contract price. These have a way of filling thick binders and cause the same difficulty in that reams of papers must be read to be certain of the present contract status, on the point in question.

Administrative Engineering can be helpful by writing realistic digests, with tabulated running summaries of the contract clauses. This digest can include record of deliveries by items, what is on contract now, graphs of the characteristics of price redetermination at various rates of performance, unformalized changes and the like, so that exact current position is determinable by a glance at one legal size sheet per contract.

Product Descriptions

Representatives of Government and corporate customers, whether they are engineers, accountants, lawyers or businessmen, often ask to go to the shop and see the product. Then the natural question is "how does it work?" If the answer is a quick, clear, generally correct description, and understandable in substantial degree by laymen, the visitors start with a favorable impression.

The opposite effect is produced on a customer when a wireman is allowed to trace the circuits from the lower contact of this relay to the midpoint of that potentiometer, and so on. It is even worse if the foreman says: "we don't know how it works, we just make it, and we're having trouble." Administrative Engineering should see to it that presentable product descriptions are on hand.

Translation of Technicalities

Many military products are highly complex, yet it is often necessary for top management to write letters concerning these projects. Whether the subject is an explanation of overrun of a research contract, with request for additional appropriation, or request for increased or decreased delivery schedule, a letter from high corporate authority often helps.

Of course, the letter can be drafted by the cognizant technicians when it concerns technicalities, but this has certain disadvantages. Many officials understandably distrust anything they don't understand. Further, the best technicians on a subject often do not produce the best explanations for laymen, and isolating the technicalities in a letter presents difficulties. Things work out better when the executive understands the problem, in its bare essence, clearly enough to apply his habitual patterns of thought—the patterns which have raised him to his present position.

Administrative Engineering should have some one capable of producing a 200-word statement of the situation, intelligible to anyone, and concerning the most complicated devices, in not over an hour or two, including clearance with top cognizant technicians. This enables the executive to proceed with assurance and with customary effectiveness. His letter has punch and a ring of truth.

Government Property Accountability

Contracts usually specify certain Government-furnished property and, particularly in Research Cost-Plus-Fixed-Fee contracts, they usually provide that all work becomes Gov-

ernment owned as it is completed, and sometimes before. It is a strict custom, tradition and law that an Army, Navy or Air Force officer is both officially and personally responsible for Government property under his accountability.

Accordingly, breadboards and odd parts constituting the residue at completion or termination of a research contract require careful listing, control and report. The rub is that nobody but the cognizant engineers knows much about the material, and the factory inventory force is helpless. If Administrative Engineering is on the spot as the work ends and the parts are being dismantled, the listing is an easy task, but if the listing is delayed many difficulties arise. Breadboards, however valuable they may have been in making prototype and production models, are often not worth much as junk, though the Government may use them for instruction purposes. It is part of the nature of a good engineer to resist and resent leaving important new work to rake over and list such material. Yet this is the only way left. Administrative Engineering can make an important contribution to the company's efficiency and prestige by insuring that engineering property is listed as the devices are dismantled.

Sitting in at Conferences

Management of military manufacture requires men from many fields of learning but conference difficulties usually center around engineering technicalities, even if the subject is taxes, law, facilities expansion or operation. For this reason some top management lawyers, accountants and businessmen make sure an engineer is on hand, knowing that it will not be long before a quick sketch, a definition or a brief explanation will pave the way to progress. Government men usually impound the sketches, for they serve to reinforce the report.

Some time ago examiners of the construction costs of a hydro-electric station made a disturbing discovery. Three large high-tension transformers, each requiring a set of expensive high-tension insulators, were listed, but five sets of insulators had been paid for. On the books there was no explanation, but the engineer quietly left the room and returned with a few snap-shots made with a two-dollar camera.

They showed the station under construction, down in a deep revine with boulder-covered sides, and with a corduroy "road" pitched at dizzy angles. The examiners looked at each other, and one said: "The mystery is not why two extra sets of insulators were needed; the mystery is how you got any of the equipment down there without breaking it. These insulators are made of about the same stuff as dinner plates. No further question on the insulators."

The Small Print

A half line of print can cost the better part of a million dollars of sorrow, but if the Sales Department made a stand at every expression capable of resulting in unwarranted trouble, it would probably never receive a contract, and the company would shut down for lack of work.

Administrative Engineering can render a real service in timely detection of "suicide clauses." One way of doing this is by reflective inspection of contracts and specifications, and another is by keeping in touch with the experiences of others through professional society activity.

One example concerns, say, a heavy bomb dolly whose specification innocently said: "Brakes in accordance with good commercial practice." That seems fair enough, and well hallowed in the jargon and customs of the trade. However, it soon became clear that there was going to be trouble about brakes. The number of wheels was fixed, and the required low center of gravity fixed the wheel diameter, which in turn limited maximum brake-drum diameter. The required clear space between wheels, and the maximum overall width limited brake-drum width; and there just weren't many square inches of brake-drum available.

"Good commercial practice" was interpreted as 20 pounds per square inch of braking surface, just as in the case of a convertible full of old maids breezing down Pike's Peak. This impasse, with consequent disruption of work, was very expensive. Administrative Engineering examination of contracts and specifications can constitute an effective protection against such things.

Research and Development Impasses

When a Research and Development contract is awarded, usually the only thing known about the required device is that it would probably be beneficial to the Armed Services if it could be made. It has never been done before, nobody knows how to do it, and there is no guarantee that it is mechanically or electrically possible; often there is evidence to the contrary.

Sooner or later on practically every job the researcher comes to a halt. He faces an obstacle which seems to have no passage over, under or through. Meanwhile the appropriation is being consumed, if it hasn't been eaten up already.

There are a few things that Administrative Engineering can do to help. These involve the psychology of failure and the location of special skills. The research engineer necessarily fails often, for he almost invariably finds the right way by trying many wrong ways. The engineer, however, tends to become discouraged at failure. He starts working longer hours and eats irregularly. Strangely, the best engineers seem to have the greatest capacity for self-recrimination,—"if we had only taken the other turn, eight turns back." His effectiveness falls off just when it is needed most.

Administrative Engineering can recognize this condition and in many ways provide encouragement, for the difference between feeling like a world-beater and feeling like a whipped cur is largely a matter of encouragement. This is the time for his associates or superiors to take him boating or golfing, or to get him the opportunity to lecture a learned society on some subject so thoroughly within his grasp that extensive preparation is unnecessary.

Turning to special skills, some men have a talent for asking questions. Perhaps an apparently foolish question will remind the stymied engineer of something useful. Difficulties surrounding a gunsight controller once suddenly disappeared at the mention of a device similar to one of the troublesome components, which had been used in electric generating stations for years. With the advent of missiles and satellites, amateur astronomers in the plant should be rounded up, and given a crack at the difficulties. Men who love a subject often have startling command of it.

Identify and harness the thinkers, for when a man can truly think, he can do so on practically any subject, and

often with surprisingly little knowledge. Until all recourses have been exhausted, Administrative Engineering's work is incomplete.

The Big Picture

Sometimes reports to top management are in splendid shape, and sometimes they are more like high policy, which was once defined as "A practice which is always followed, which cannot be disobeyed, and the reasons for which are unknown, because the man who initiated it died without telling us."

Most reports are needed primarily by one executive, and his nature is important. If he habitually excludes from his office anyone seen to be carrying more than one piece of paper, and who prefaces his remarks "Now, Mr. Jones, there are only six things I need to know about this before calling Washington," he wants brief, simple, concise, clear reports. These are more difficult to devise than bulky, complicated reports.

If the boss likes to do most of the work himself, working with myriads of figures in big thick binders, more detailed reports are needed. Remember that by the time a man rises to the point where it makes much difference whether he reads a report, his eyesight often isn't what it used to be, and he appreciates the thoughtful convenience of clear, coherent, well-spaced reports.

Any situation, including the operations of a supercorporation, resembles a pyramid. At the bottom is a multiplicity of detail—the time card, material requisition level. This is condensed somewhat at the next level and on a still higher plane reports have been reduced to operating statements, standard financial statements and the like. This level is later compressed into a page or two of summary. There are various graduations between these levels. By an educated guess at where a man fits on the pyramid, the general nature of his statements can be determined, subject to refinement.

The main thing about the top summary is the Bad News. When corporate affairs are running smoothly, top management can relax to some extent. But bad news requires serious action, and time is usually of the essence. Don't hide bad news.

EDITOR'S NOTE: Other articles published in *Product Engineering* recently on the subject of engineering administration include:

"Product Development—The Project Engineer's Place," Louis Scheib, December 1955 p 189.

"Estimating Government Contracts," M. J. Phillips, January 1956 p 183.

"Project Group vs Service Group in Engineering Development," A. H. Kuriloff, August 1956 p 198.

"International Engineering for a Profit," H. A. Toulmin, Jr., August 1956 p 196.

MORE BOOKS

(on mathematics)

Received just one week too late for inclusion in last month's *Engineer's Bookshelf*, this short list of mathematical references couldn't be ignored. The author is one of our favorite mathematical experts and a serious hobbyist in number theory. His discussion makes this plain.

CHARLES R. SEXTON
Walnut Creek, Calif.

Here is a list of 14 super-selected mathematical tables and texts for the engineer's bookshelf. In fact, it might be termed the complete engineer's small mathematics library. There is a certain amount of choice among several of the items. For example, unless an engineer's office or staff is large, either the "shorter" volume or the two volume set of Chambers's Tables would be acquired, not both. Having one of the Chambers's Tables, some might not want Barlows, as they perhaps would not need the latter's high range. Conversely, a close-fisted engineer might buy either Scarborough or Nielsen, but not both. However, this would be a mistake, because in this large field, each amplifies the other in many spots. Incidentally, both explain the theory and use of the various tables of interpolation coefficients listed here.

Bronwell gives advanced aspects of engineering mathematics, while Scarborough gives the most elementary and practical approach to the simpler problems met by most engineers, such as solving for roots of equations, solution of simultaneous equations, least-squares curve fitting, etc. Hence Scarborough is something like a very practical algebra book although he deals with some higher processes.

Included are books for the benefit of hobbyists. These are seemingly totally "impractical." However, they give the last, and elegant touch to a carefully selected little library; the cherry in the "old-fashioned," or the icing on the cake, so to speak. Many engineers have noticed the cyclic repetition of decimals in calculating machines, and would like to explore the subject, but do not know where to start to satisfy their intellectual curiosity. Practical

aspects occasionally arise; for example, in recent years "continued fractions" were suddenly dragged out of the mathematical closet, and used in automatic computing machines. Wright has one of the few elementary chapters that I have noticed on this subject.

Although many offices generally deal with rather simple mathematics, James' *Mathematics Dictionary* should receive enthusiastic approval anywhere. We have used it a number of times to guide and correct our staff in preparation of material for hearings. In one instance its use caused an outside man with ideas adverse to us to back down in a dispute over misleading terms that he had used in a printed report. Those who have used Fletcher, Miller and Rosenhead consider it priceless. This is the type of book that one is tempted to keep in a locked bookcase.

The books listed are, in effect, for engineers who use desk calculators, slide rules or pencil and paper. No attempt has been made to include books dealing directly with the vast and ever-widening field of automatic computing machinery. However, much fundamental theory that must be understood when studying the applications of automatic computing machinery is given here, for example; infinite series (Bronwell, Scarborough), continued fractions (Wright), solution of simultaneous equations and matrix inversion (Scarborough, Nielsen), numerical solution of differential equations (Scarborough, Nielsen).

A Mathematical Library

General

Fletcher, A., J. C. P. Miller, and L. Rosenhead. *An index of mathematical tables.* McGraw-Hill Book Co., 1946. Out of print. New edition expected possibly in 1957. Extraordinarily useful in connection with all types of elementary and advanced calculations.

James, G., and R. C. James. *Mathematics dictionary.* D. Van Nostrand Co., 1949. $10.00. Surprisingly helpful to a wide variety of engineers, even to those doing rather elementary operations.

Tables, General

Comrie, L. J. *Chambers's six-figure mathematical tables.* 2nd ed. 2 vols. D. Van Nostrand Co., 1949. $10.00 ea. $17.50 set. Masterwork of a great craftsman; leaves nothing more to be desired in the way of elementary functions.

Comrie, L. J. *Chambers's shorter six-figure mathematical tables.* Tudor Publishing Co., 1954. Order from Harlem Book Co., 221 4th Ave., N. Y. 3, N. Y. $6.50. A skillful condensation of the above; one or the other should be in every engineer's library.

Tables, Specific

Comrie, L. J. *Barlows tables.* 4th ed. Tudor Publishing Co., 1952. Order from Harlem Book Co., 221 4th Ave., N. Y. 3, N. Y. $3.95. Very high ranges for common powers and roots, reciprocals, factorials, etc. Easily interpolated to many decimal places.

H. M. Nautical Almanac Office. *Interpolation and allied tables.* British Information Service, 45 Rockefeller Plaza, N. Y. 20, N. Y., issued 1956. $0.90. (Plus $0.05 postage.) An astonishingly low priced "nugget" for those engaged in table making, interpolation, numerical differentiation and integration. A companion booklet entitled *Subtabulation*, to be published in 1957, may also be of interest.

U. S. National Bureau of Standards. *Table of Lagrangian interpolation coefficients.* Columbia University Press, 1944. $7.50. Finest table of Lagrangian coefficients; useful in curve plotting, interpolation, table making, roots of equations, etc. Very efficient with calculating machines.

U. S. National Bureau of Standards. *Tables of Lagrangian coefficients for sexagesimal interpolation.* Applied Mathematics Series No. 35. For sale by Supt. of Documents, Wash. 25, D. C., 1954. $2.00. Although less comprehensive than the table above this may often be used in its place for decimal intervals, provided that the decimal interval can be expressed as $N/3600$, where N is any integer less than 3600.

Various tables of orthogonal polynomials. These are used in connection with a high-speed method of least squares curve fitting where one variable is evenly spaced. See *Product Engineering*, April 1956, page 171, where a detailed list of available tables is included. Reprints of some of these tables are available at little or no cost from the issuing agency.

Tables, Hobbyist

British Association for Advancement of Science *Mathematical tables.* vol 8: *Number-divisor tables.* Cambridge University Press. $3.75. Has factor tables for integers to 10,000; also other tables useful to hobbyists. Some may prefer merely a factor table, with much higher range, such as the companion vol. 5, *Factor table* (range to 100,000). Another companion table is vol 9; *Table of powers* which gives very high powers of integers. Professor D. H. Lehmer's *Guide to tables in the theory of numbers*, (out of print) is very helpful. Engineers who expect to purchase either of the Chambers's tables listed above will find factor tables and lists of prime numbers in these volumes.

Texts, Practical

Bronwell, Arthur. *Advanced mathematics in physics and engineering.* McGraw-Hill Book Co., 1953. $6.50. A masterly one-volume exposition of the higher mathematical functions and processes used in today's research problems.

Munroe, M. E. *Theory of probability.* McGraw-Hill Book Co., 1951. $5.00. A compact, modern treatment of a subject that has become increasingly important to engineers. For a more extended treatment of certain aspects of probability see Fry, T. C. *Probability and its engineering uses.* D Van Nostrand Co., 1928 $9.50. and Uspensky, J. V. *Introduction to mathematical probability.* McGraw-Hill Book Co., 1937. $7.00.

Nielsen, K. L. *Methods in numerical analysis.* Macmillan Co., 1956. $6.90. Comprehensive yet compact and easily understood volume; in addition to standard material has special data on Crout's method, orthogonal polynomials, curve fitting, complex roots of equations, etc.

Scarborough, James B. *Numerical mathematical analysis.* 3rd ed. Johns Hopkins Press, 1955. $6.00. Outstanding for practical exposition of solution of algebraic and differential equations, interpolation, curve fitting, simultaneous equations, etc.

Texts, Hobbyist

Ore, Oystein. *Number theory and its history.* McGraw-Hill Co., 1948. $5.50. Fascinating historical data; excellent chapter on repeating decimals. A small factor table is included in the center of this book (range 1-5000).

Wright, Harry N. *First course in the theory of numbers.* John Wiley & Sons, 1939. $2.90. Simply written and easily understandable; has an uncommon chapter on continued fractions, a subject that has recently become quite practical in connection with automatic computers.

When to Choose

A NON-CLUTCH DRIVE

- Disconnect
  - To start power take-off unit
  - To start and stop quickly
  - Frequent cycling
  - Reversing and gear shifting
  - To start gas engines
  - To permit angular adjustment
  - Dual drive
- Inching and jogging
- Controlled torque
  - Variable speed
  - Controlled slip tensioning
  - "Rattle" overload limit
  - Overload trip (manual or automatic reset)
  - Braking
- Starting
  - High inertia loads (centrifugal clutch, fluid coupling)
  - Synchronizing (as in Synchromesh transmission)
- Single revolution
- One way
  - Indexing
  - Non-reversing
  - Freewheeling and overrunning
  - Dual drive
- Overspeed trip

Table I—Clutch Functions vs Drive Arrangements which Give Equivalent Results

Desired Function	Quick-disconnect Couplings	De-mesh Gears	Friction Drives	Individual A-C Motors	D-C Motors	Electric Transmissions	Torque Converters
Infrequent stop or disconnect							
Frequent cycling							
Reversing and gear shifting							
Inching and jogging							
Variable speed							
Tensioning							
Overload limit				(See note 2)			
Overload trip				(See note 2)			
Braking							
Starting heavy loads							
Single revolution and indexing							
Positive no-back protection							
Free-wheeling							
Dual drive (See note 1)							

Note 1 Slow and high-speed motors, or turbine and electric motor drive. Criterion: idle drive unit or motor must not rotate with other drive unit.

Note 2 High kinetic energy of motors can cause damage if drivin unit jams or is suddenly overloaded

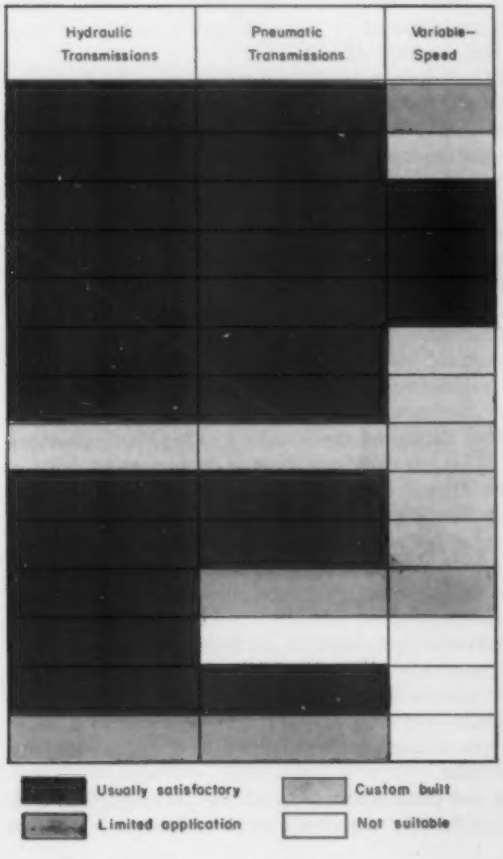
Mechanical clutches have several alternates when the mechanism requires starting and stopping, reversing, inching, speed changing, cycling, indexing, tensioning, braking, free wheeling. Here are comparisons of available methods.

A. F. GAGNE, JR.
Professional Engineer
Binghamton, New York

WHEN a relatively constant power source must drive a machine requiring intermittent or variable-speed operation, some method of coupling is required. This may be a disconnecting drive, friction drive, line-voltage control for a-c motors, torque motor, d-c motor drive, torque converter, hydraulic or pneumatic transmission, or a mechanical variable-speed drive. Each method has advantages and limitations, Table I, depending on the drive functions of most importance.

Disconnecting Drives

Some solid and flexible couplings, Fig. 1, can be connected or disconnected in less than a minute. They cut first cost where frequent clutching and declutching is not required and where the drive can be conveniently stopped for each engagement or disengagement. Geared drives are disconnected by sliding or backing the gears out of mesh. Such arrangements have been used on "back gears" of machine tools and lead screws on lathes.



Light-duty drives, Fig. 2, may often be "clutched" while running, but high-inertia or high-speed drives must be shut down to mesh or unmesh gears. It is therefore desirable in high-performance machinery, such as the machine-tool speed-change system in Fig. 3, to use clutches with gears running in constant mesh.

Friction Drives

Disconnecting is generally more satisfactory with friction drives which may be separated or re-engaged without serious effects while running under load. This arrangement is found on feed hoppers and yarn winders.

Many electric fans use another type of friction drive in which the worm gear for the oscillating crank is clamped between shoulders by a threaded knob extending

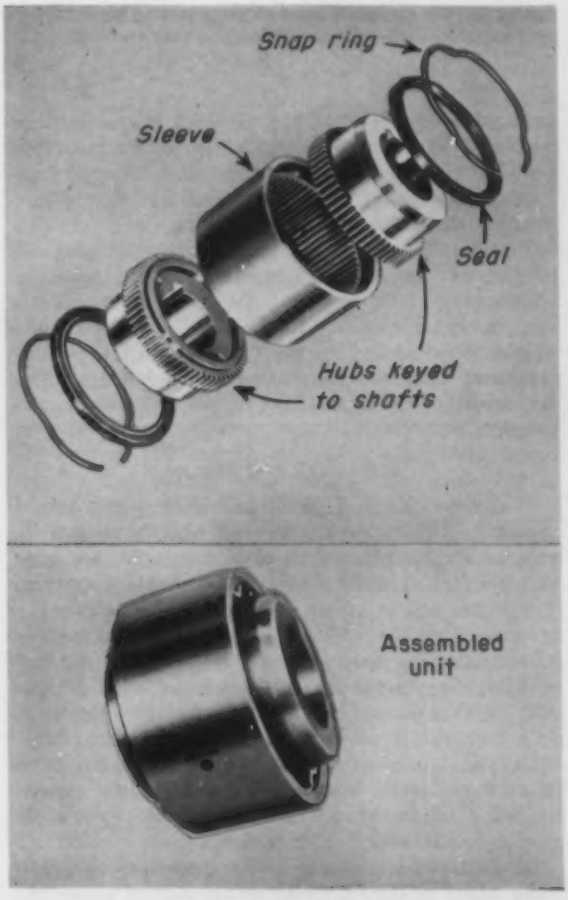


Fig. 1—Gear-type flexible coupling can be uncoupled or coupled in seconds, with only a screwdriver. Shafts are coupled by sliding sleeve over hub, pressing seal in with screwdriver and snapping in snap ring. (Sier-Bath Gear & Pump Co., Inc.)

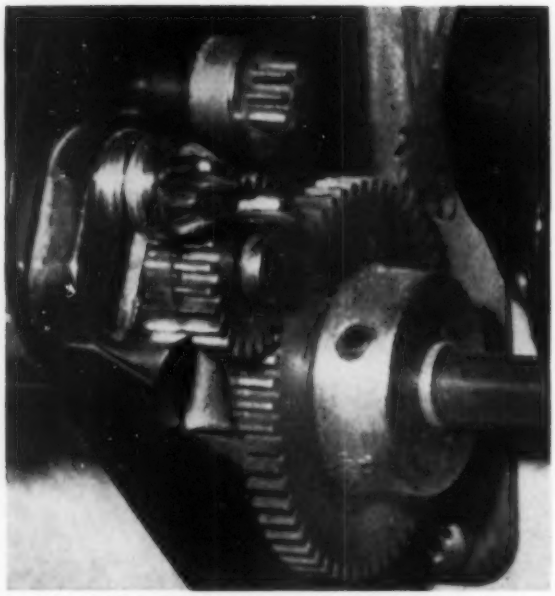


Fig. 2—Idler gear drive in small white-printer. By loosening wing nut, quadrant may be backed off to permit reversal or change of gears. (Rotolite Co.)

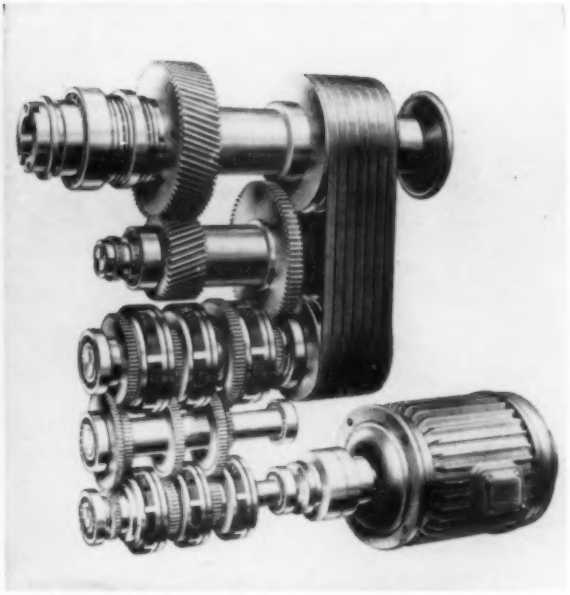


Fig. 3—Milling-machine gear layout with constant-mesh gearing. Six Electro clutches and two mechanical clutches combine to give 18 speeds. (I-T-E Circuit Breaker Co.)

to the outside of the housing, Fig. 4. When the knob is backed off to stop oscillation, the worm gear spins freely on the shaft. An additional twist brings a flange on the knob against the inside face of the gearcase cover to clamp the fan in any desired position.

V-belt drives can be disconnected by slackening belt tension, an arrangement frequently seen on gas-engine lawnmowers. It is significant, however, that at least one manufacturer has found a selfcontained centrifugal clutch simpler to install and operate and more attractive to the customer. Because a hand lever and associated parts are not needed, the installed cost of the centrifugal clutch is less.

Individual A-C Motors

While the first cost of an individual motor drive is sometimes higher than for a group drive, because of the need for a control system for each motor, machine operation is safer and easier; machines are simpler to relocate if required; and maintenance is reduced. Clutches may be retained on the machine after motorizing to facilitate starting, stopping and inching. At times, it may only be habit since power-press manufacturers often dispense with clutches on cold-headers and other machines which do not have to be single-stroked for hand feeding.

High-slip motors are sometimes used in individual drives to overcome cyclic torque peaks or high load inertias. Efficiency is somewhat lower while running unless the more-expensive wound-rotor or d-c motors are used.

Rapid stopping can be secured inexpensively by a hand brake which permits stopping at any desired point. Integral magnetic brakes can be substituted in place of manual operation to obtain push-button control, but usually cost slightly more. However, magnetic brakes maintain braking action even when idle, which is helpful sometimes. This and other remote-control means for stopping, including plugging and d-c braking, are well known. When frequent or rapid stops are desired, better results are obtained by declutching the motor and stopping the machine directly.

Practical limit on start-stop cycling of a direct-coupled 3-phase electric motor is ordinarily about 30 cycles per min when the inertia of driven parts is relatively low, as for a tapping-machine spindle. More rapid cycling can sometimes be accomplished by using: (1) low-speed (1200-rpm) motors, (2) high-slip motors (NEMA Design C or Design D) to minimize heating and acceleration time, (3) forced ventilation if enclosed motors are required, or (4) high-temperature motors.

For machines that contain sub-mechanisms which must be started and stopped independently of the main drive, the tendency is toward individual motors. Decision between a clutch and a separate prime mover will depend on:

Precise timing or synchronization between sub-assemblies. This necessitates a clutch, disconnecting drive or a servo drive. Example: leadscrew and spindle when cutting threads on a lathe.

Extreme high-speed requirements for one mechanism. This may favor the use of an independent motor. Example: substitution of direct-connected motors for belt drives on high-speed grinding spindles.

Duration of operation. A truck refrigerating unit must be independently powered to maintain refrigeration during layover periods.

Distance and weight. What is desirable in a small knee-type milling machine may not be desirable in a large planer-miller.

Cost and practicability. In a home phonograph, a take-off drive for the record changer mechanism is cheaper

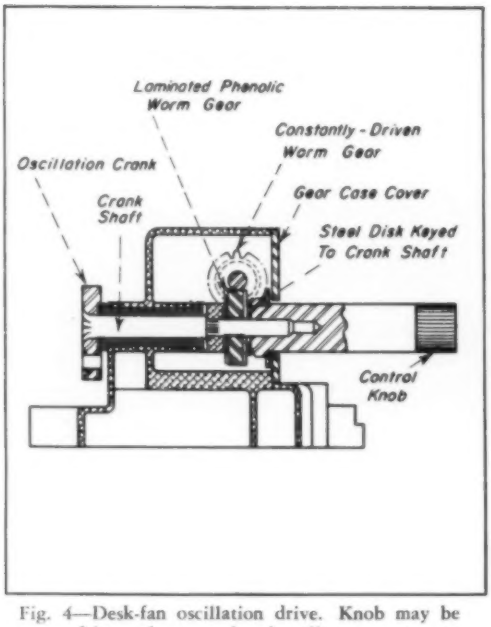


Fig. 4—Desk-fan oscillation drive. Knob may be screwed in to clamp on the phenolic worm gear, or out to engage gearcase cover. (Westinghouse Electric Corp.)

Fig. 5—"Sno-Train" has 16 wheels, each individually powered by d-c motors through gear reducers driving from inside the rim. This gives high traction over ice or snow and wear-free braking on downgrades. (R. G. LeTourneau, Inc.)

than a separate drive and control. In a "juke box," on the other hand, the record changer is comparatively heavy and requires its own motor.

Torque Motors

Slip clutches permit driving against a fixed stop without damaging the drive motor either by impact or overheating. Torque motors can perform the same function because they can be stalled indefinitely with minimum wear or noise. Overheating is prevented by making the motor sufficiently large and using a special rotor to dissipate the extra heat generated over the portion of total time that the motor is stalled. Torque motors are seldom used in sizes larger than the 326 frame. (See article on torque motors on page 146 in this issue.) Applications range from full stall drives such as clamping devices, chucks, and brake operators, to slip and tension drives such as cable reels. In the fractional-horsepower field, torque motors are used effectively to power instruments, furnace dampers, louvers, relays, film and carbon-paper reels.

D-C Motors

The d-c motor offers at least two major operating advantages over adjustable-speed a-c drives: improved starting, and wide speed range, which are responsible for the development of converters permitting use of d-c motors on a-c power.

Converters can now be obtained with many special operating features, such as close regulation at any selected speed, inching or creeping speeds, timed acceleration and deceleration, dynamic or regenerative braking, controlled torque, controlled reversing, remote control, and multimotor coordination. Converters have been used successfully on conveyors, lathes, printing presses, and winding devices. Types include: Ward-Leonard system motor-generators; plate rectifiers with voltage varied by autotransformers or magnetic amplifiers; phase-shift electronic rectifiers; and rotating amplifiers.

Although d-c converter drives have many useful clutch features, all converter drives are more expensive to purchase and to operate than clutch-motor-brake combinations.

All-Electric Transmissions

Despite the high cost as compared with friction clutches, all-electric transmissions are used on diesel-electric ships and trains to obtain gearless torque amplification with high efficiency, smooth acceleration, regenerative braking, full reversibility, infinitely adjustable speed, and elimination of drive shafts and couplings. For example, the 16-wheel "Sno-Train," Fig. 5, is powered by a central diesel-powered generator with individual d-c traction motors on all wheels. Large machine size and long transmission distances may favor an electric drive.

Torque Converters

Some of the advantages of an all-electric transmission, without its cost and electrical complexity, are offered by the torque converter. In fluid couplings, as in other clutches, input and output torques are equal at all times. In torque converters, output torque increases with increasing slip until at stall the input torque is multiplied three to six times.

Efficiency is comparatively low because the blading is designed as a compromise between different operating speeds. A mechanical friction or jaw clutch can be added to lock input to output shafts after starting, thus increasing the efficiency at normal running speed. However, even on machines having a mechanical lock, there may be extended periods of lower speed operation during which

Fig. 6—Variable-speed 20-hp hydraulic transmission available as a standard package. Movement of lever 50° to either side of neutral operates servomotor to change shaft speed in either direction. (The Oilgear Company)

20 to 60 per cent of input power is converted to heat. An oil cooler or radiator is therefore essential in all units larger than small automotive torque converters.

Other auxiliaries sometimes needed are a pressuring pump to prevent cavitation, a reserve tank, instruments to indicate or signal temperature and pressure, a disconnect clutch, a gear transmission for reverse driving or for maximum torque-speed range, and a speed governor for the output shaft. The torque converter is neither cheap nor light in weight; it does, however, improve the operation of internal-combustion engine drives so its use is increasing.

In trucks, tractors and locomotives the converter gives high starting effort without danger of burning clutches, stalling or jerking, and reduces the number of gear shifts necessary to pull a varying load. It has the ability of the converter to deliver maximum torque immediately on demand. Convenience of operation is a selling point on automobiles, as well as relatively simple and trouble-proof operation.

On cranes and winches, the converter allows the load to "hover" or raise or lower a small amount, simply by adjusting the throttle. Power application is smooth and steady, avoiding snap and jerk on lines caused by shifting gears. Operation and maintenance time are reduced.

Standard sizes commonly range from 30 hp at 1800 rpm to 1000 hp at 1300 rpm. Larger sizes to 5000 hp are built. Whether standard or not, torque-converter drives usually must be specially engineered to suit prime mover and load.

Hydraulic and Pneumatic Transmissions

Hydraulic pump-motor combinations are directly competitive with all-electric drives. Hydraulic power is advantageous when the application requires straight-line motions, continued stall, rapid cycling or change of speed, or involves explosive atmospheres. Fig. 6 shows a standard package unit offering full-range variable speed and overload protection.

In contrast to hydraulics, pneumatic transmissions are less affected by leakage or varying temperatures and offer no fire hazards. But they are often noisy and less efficient. In many applications, such as aircraft and hand tools, light weight and avoidance of return lines may be deciding factors. Maintenance in general is low, particularly when air tools are compared to electrical tools, and extreme speeds are readily attained.

Mechanical Variable-Speed Drives

A number of standard variable-speed drives can be adjusted to deliver zero speed or, in some cases, to reverse. These include: Goodrich Planetary V-Belt Drive, Graham, Lombard Differential Drive, Reveo "Zero-Max," and Speed Control Corp. "Specon" mechanical and electrical differential drives. Because these units can be set to zero speed easily, a separate clutch may not be needed. Other characteristics are: locked output shaft at zero speed setting; possibility of creep because of wear or imperfect setting; multiplication of motor torque at low output speeds; ability to change speeds while motor is running; excellent speed regulation; inclusion of an overload release in some designs; remote control by servomotors or other methods in some designs; low losses at all speeds, permitting prolonged idling. Pre-selection is not possible as with all-electric or hydraulic drives. Also capacities are usually limited to a few horsepower, although large units are available in standard sizes through 40 hp at 1750 rpm, with capacities over 400 hp obtainable. Because these transmissions are not designed primarily for clutching functions, in some types the speed-changing system is not suitable for continual adjustment. This point should be checked with the manufacturer.

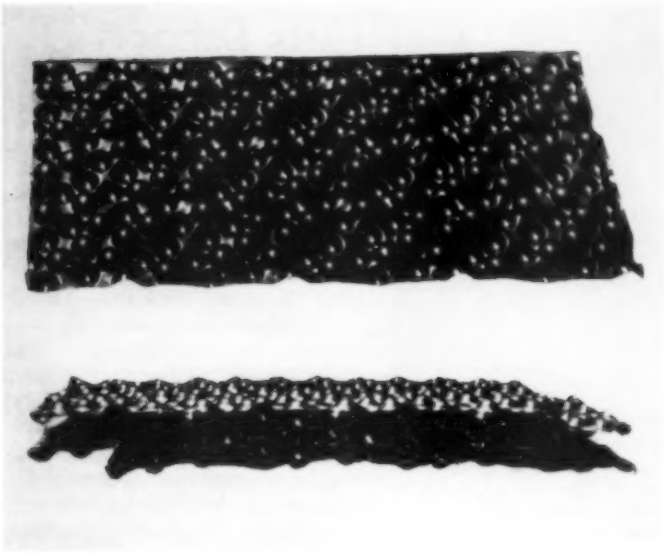
EDITOR'S NOTE: For more detailed data on power-transmission methods see these recent articles:

Gear Drives—"Gear-Shift Arrangements," April 1957 page 188, illustrates 13 ways of arranging gears and clutches. "Lubrication of High Capacity Gear Drives," May 1956 page 173. Methods for calculating lubrication and cooling requirements. "Measurement and Control of Chatter in Gear Drives," December 1956 page 168. Chatter analysis by instruments; equations for computing speed variations. "Minimum Inertia in Geared Drives," January 1956 page 186. Dynamic analysis of a hoist drive develops equations for heavy starting loads.

Mechanical Couplings—"Design of Toothed Mechanical Components," December 1955 page 219. Nomograph for determining optimum tooth angle to transmit a given torque. "Coupling of Parallel Shafts," March 1954 page 186. Nine methods for coupling where shafts are parallel or offset. "Mechanical Components for Automatic Control," September 1954 page 169. Characteristics and application of various types of clutches, gear trains and commercially available mechanical elements. "Mechanical and Electrical Variable Speed Transmissions," Mid-October 1955 page E20. Seven speed-changing devices.

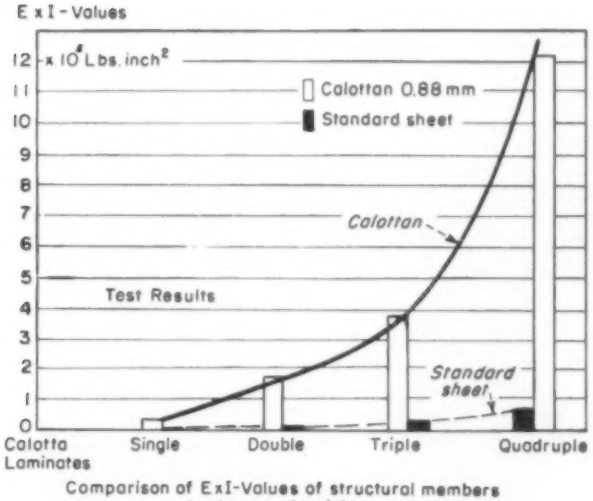
Fluid Couplings—"Smoother Shifting in Cadillac Transmission," March 1956 page 150. Fluid coupling combined with sprag clutches replaces a multi-disk clutch. "Nomograms Relating Hydraulic, Pneumatic and Electrical Energy," Mid-October 1956 page J22. "Fluid Clutches for Electric Drives," August 1954 page 174. Combination of fluid clutch with squirrel cage motor to start high inertia loads. "Torque Convertors for Industrial Applications," Mid-October 1955 page E2. Selection data and performance curves.

Electric Drives—"Driving High-Inertia Loads," April 1956 page 142. Selecting best combination of motor and fly wheel inertia for cyclic power requirements. "Axial-Air-Gap Motors for Machine Tool Drives," September 1955 page 129. Special high-inertia motors to minimize effect of peak loads. "Controlling Temperature Rise in Induction Motor Drives," January 1957 page 167. How to circumvent heat developed by the motor. "Safety in D-C Motor Controls," December 1955 page 193. How to prevent damage to machines and fire from motor overheating.



ACCORDING TO CALOTTAN-TECHNIK, possible applications of the material are construction of flutter-free aircraft wing and tail assemblies, shell-type hulls, and boilers of high ductility. So far trials have been made using conventional roll mills equipped with one final stage roll having the cup-shaped element pattern.

Fabrication Technique Doubles Bending Resistance



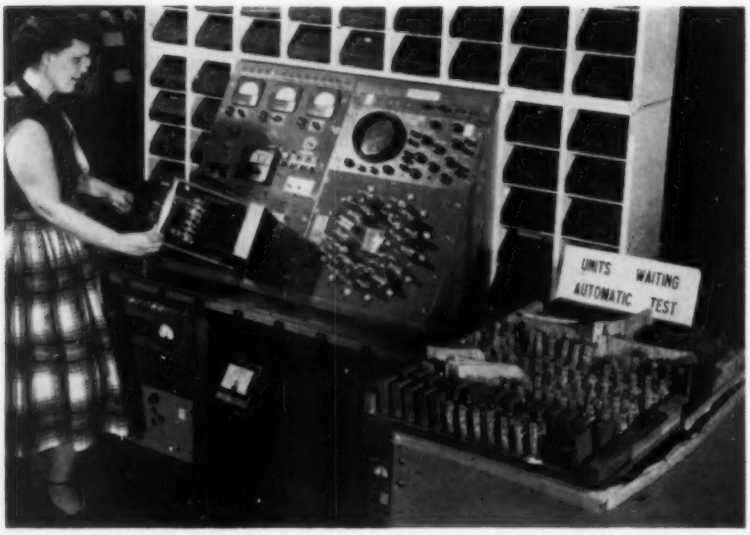
Comparison of ExI-Values of structural members having equal weight

Any sheet material—metal, plastic, pressed wood, or glass—reportedly has its bending or buckling resistance increased by at least two-fold by a fabrication technique developed by Calottan-Technik, Frankfurt, West Germany. The technique stems from the idea of casting or shaping into the surface of the sheet a pattern of elevations and projections which will give no preferential axis of inertia. Any cross section through the material presents a nonuniform stress plane.

With almost ten times the bending modulus of flat sheet, the company estimates that the calottized sheet would halve the materials costs for any desired bending strength. Also, the new technique makes the material 80 to 100 per cent more resistant to impact.

Two or more calloted sheets can be joined into a single panel, which is said to increase the buckling and bending strength by more than ten times that of a similar weight flat-sheet structure. The sheets are welded at mating projections—a depression of the outside sheet with an elevation of the inside sheet. The double sheet construction dampens vibration and sound, and has good insulating qualities. The hollow framework between the two sheets can be filled with a material for greater impact resistance, or designed as a circulatory system.

The calloted sheets are adaptable to conventional shaping methods. When separate siding sections are joined together, the cup-shaped elements can be made to overlap and interlock, and reduce the number of required fittings. The exact spherical diameter and depth of these depressions depends on the quality and thickness of the material used.



THIS AUTOMATIC MOLDED UNIT TEST SET makes static and dynamic tests of molded units in production quantities. Such units are subminiature amplifiers, servo-loops, divider networks, and the like, encapsulated in plastic. The tests are conducted by setting up an a-c or d-c signal input to the unit under test and comparing the output against a standard value. Programming is accomplished with a patchboard which programs the input parameters and output comparison circuits. The machine is connected to many supply voltages to furnish a variety of inputs. A continuous load of 14 mold units is maintained, each unit undergoing 14 or more tests. By switching, 28 tests can be placed on one patchboard. This equipment reduces test time by 50%.

AN AUTOMATIC TURNS-RATIO checks the turns in multiple winding transformers, and was designed for high-volume, one type test, with some variation of parameters. It has an automatic turns-ratio bridge, card-controlling programmer, showing a digital read out. One loading will handle 24 transformers of the same type with up to 5 windings each. The machine will step ahead as long as the turns-ratio falls within the limits programmed into the punched cards. If these tolerances are not met, the machine will stop, indicating the actual turns-ratio on the digital display. One indicator lamp shows which transformer failed, and another lamp shows which winding failed. Total test time is less than 15 sec per transformer, and the machine cut the labor content of the operation by 90%.

Automatic Testing Saves Time, Cuts Labor Requirements

By completely automatizing its testing techniques, the Air Arm Div. of Westinghouse Electric Corp., Baltimore, Md., was able to reduce the total test time on one type of fixed fire control system from 1000 to 200 hr. Also, labor is more efficiently utilized: scarce technicians are relased for more difficult work, producing and servicing the automatic equipment; and more semiskilled labor is used to perform the complex testing. Besides shortening the manufacturing cycle, schedules, and inventories, the reliability of the military products has improved. For example: in one instance Westinghouse found that after some complicated equipment was checked manually for circuit accuracy, the same equipment was put through an automatic circuit tester which revealed a 20% inaccuracy in the manual testing procedure.

The Air Arm, Electronics, and Ordnance Divisions comprise the entire Baltimore division all of which is engaged in military work. The Air Arm Division builds fixed fire control systems, flexible fire control systems, missile and special systems. In a study it was found that test hours comprised 30% of the total hours required to produce a system, using traditional methods of testing. Some test hours involved a considerable number of hand adjustment; and some were two-man operations.

The study then concentrated on operations that could be mechanized, such as: high volume repetitive testing with small variations of parameters, such as transformer testing; and low volume repetitive sequential testing demanding large variations of parameters. Computer testing is a good example here.

It was determined that progress could be made on component testing at incoming inspection and transformer manufacturing; wiring harness checkout at the assembly stages; unit and subassembly testing; major assembly testing; and composite testing.

Some of the automatic test equipment is shown here. Those not shown are the:

Automatic DCR, which tests transformers for d-c resistance of the windings. The resistance range may be 0.001 ohm to 10,000 ohms. The system uses a d-c resistance bridge and a card-controlled programmer with a three digit read out. Once testing is initiated, the system will automatically step ahead, recording on a test indicator whether the unit passes or fails according to the limits programmed into the punched card. This test set differs from other automatic test equipment in that the automation loop is completely closed. Included in the set is an automatic calibration unit which requires that every time the system changes its resistance range, it must pass an internal calibration prior to any transformer testing. If the system failed in calibration, it would stop operating. Twenty-four transformers, checking three separate windings per hookup can be tested, taking two seconds to test one unit. This is ten times faster than manual testing.

The Automatic Computer Test Stand basically sets up various input parameters in order to establish whether the computer can handle the flight problems satisfactorily. The set is designed for low quantity, but multiple precise sequential operations and readings. The input parameters are fed into the computer through a ladex driven DeKavider. Speed of operation has been increased by a factor of 8 to 1 during composite test, and by a factor of 2 to 1 during alignment. Savings of over 50% have been realized with this machine. Westinghouse hopes to develop a type of computer tester which can be operated by a semi-skilled man in the field.

An Automatic Function Tester makes continuity, leakage, resistance, impedance, a-c voltage, and d-c voltage measurements at a rate of three tests a second. An adapter which plugs into the top of the supertester permits 400 separate tests. This adapter has selector switches that program the test sequence, select standards for each test, and direct the bridge and range selecting circuits. The manpower required to circuit check the equipment has been reduced by 75%; the average circuit time has been reduced by 90%.

ANY CABLE HARNESS is circuit checked by this Automatic Cable Harness Checker. Each wire is tested for accurate connection. Then the checker will hi-pot every wire in the harness. Also, each resistor, panel light, switch, relay, and solenoid is tested. Two test voltages are used: 28 v d-c for continuity tests, and 500 v d-c for leakage tests. Each circuit is approved or rejected, indicating by way of "open" and "short" indicator lights. A matrix chart with the circuit identification is placed on the analyzer at left. Vertical and horizontal reference lights show the circuit under test as the machine goes through the circuits automatically. The machine can test 200 circuits for continuity, shorts, and leakage simultaneously. Adapters can increase this to 400, 800 or 1200.

GANGED PRECISION POTENTIOMETERS are checked on this Potentiometer Checker for resistance, linearity of conformity, dielectric strength, and electrical noise. An indexing device will index the shaft through 360 deg in 7.5 deg increments at the rate of one increment per second. The machine operates on a fixed time base of one test operation per second through a sequence of fixed and variable switching programs. The programs are set up on punched cars, and can be varied from one second to the next. The card information capacity is 24 digit numbers plus control and identification signals. Up to 84 cards are needed to completely test a 14 cup-gang. A labor saving of over 90 per cent resulted with this piece of test equipment.

Outlook For The Atomic Equipment Industry

"From the point of view of the equipment manufacturer, the atomic energy field today represents an unusual business problem. There has been a tremendous national investment and a correspondingly large industrial effort which has developed without the existence of an immediate profit incentive. This has been the result of major national objectives directed and paid for by the government and associated with military defense and anticipated national power needs." So said Mr. Chauncey Starr, General Manager of Atomics International Div., North American Aviation, at a recent American Management Association special conference on Managing The Atom.

		Billions of Dollars 1956–65	1966–75
Nuclear Steam Plants			
Large Central Station	U. S.	1	9
	Foreign	0.5	10
Small Station	Foreign	1	10
Ship Propulsion	Naval	1	1
	Merchant	0.3	1.5
Process Heat		not determined	
Research Reactors		0.1	0.1
Fuel Elements	U. S.	0.5	2.0
	Foreign	1.5	5.0

The bulk of future sales in the atomic energy equipment field will be of nuclear reactors, rather than in the nuclear instrumentation, radiation equipment, and other fringe activities of the field. Any nuclear reactors that are built to produce plutonium for military purposes should be excluded from these sales expectations, as these installations are built in a limited time and do not represent a repeat or growing business. However, nuclear power plants built for military propulsion such as Naval use, may be considered as a repeat type of business and might be included in a future business analysis.

In the nuclear power plant market, orders will not be placed until their reliability and economics of operation have been established. Even under the most optimistic assumptions concerning the performance of these first few plants, it is not likely that the influx of orders for these plants will become evident for five years.

The sales estimate during the decade 1956 to 1965 and from 1966 to 1975 are shown in the above table.

Included in this table are research reactors and fuel elements, and the sales indicated represent the total cost of the plants of which the atomic equipment is only a small part. Because of the 2-3 years delivery time to the customer, actual income to the manufacturer from these sales is about two-thirds of that shown.

To evaluate the estimated atomic equipment market, about one-half of the cost of the nuclear power plant involves engineering and construction of a semi-conventional nature, and should not be considered as part of an atomic equipment manufacturer. One-fourth of the total cost represents equipment like turbines, generators, pumps, pipes, etc. The remaining one-fourth of the total cost includes the nuclear reactor special handling equipment, and special heat extraction devices. Thus, of the total sales shown in the table for power plants, only one-fourth is for the atomic equipment manufacturer.

Outside the United States, the U. S. manufacturers have traditionally supplied about one-third of the power plant equipment, and it is expected that they will continue to hold this position.

"From the point of view of the atomic equipment manufacturer, the most serious single obstacle in this business is the lack of a satisfactory product to sell, and our most urgent programs should be those that will lead to salable power plants. While there will be much progress within the next five years, we must all face the probability that a demonstration of reliable and economic performance of nuclear plants will not have been made by that time," said Mr. Starr.

In addition to the development problems associated with the nuclear power plants, the sale of such plants requires the existence of an industrial complex in any country which can properly absorb them. Nuclear power plants must be supplied with fuel elements, must dispose of radioactive wastes, may require chemical plants for reprocessing the fuel and must have a highly trained technical staff to maintain and operate the plants and services.

Based on business prognostications alone, the atomic equipment industry lacks a profit incentive for the next decade. The manufacturer in the atomic equipment field is looking years ahead for the profit incentive.

News Briefs . . . .

If Boeing Airplane Co. accepts a proposal of the Seattle Professional Engineering Association, the salaries of established engineers working for that company will be adjusted annually on the basis of increases in salaries paid to newly hired engineers. The salaries of the new hires would be evaluated each August, after the recruiting of recent engineering graduates, and the same percentage increases in starting salaries over the previous year would be applied to the established engineers. This would gage engineering salaries to the increases the company would have to meet in the free market in meeting the competition of other companies.

Two new magnesium finishing processes have been developed by Torco Products, Inc., 6135 S. Central Ave., Los Angeles, Calif., to replace the Dow #17 and #18 process. The new

single package processes have been approved by the Dow Co. and are designed to provide magnesium with better corrosion and abrasion resistance, better paint bonding properties, and to eliminate the need for precise measuring and mixing of several chemicals. Also, the processes do not require complicated control procedures. Turcoat 5245-2F (Dow # 17) is a production line process for providing corrosion resistance and paint base qualities. The one-package powdered material is mixed with water. Turcoat 4091 (Dow #18) is a liquid process for touching up coated magnesium that has been scratched or abraded. The process does not require electrical current and is used where assemblies are too big for immersion.

The British Admiralty is working on a nuclear propulsion plant for merchant ships as well as submarines. Feasibility studies have been undertaken by the engineering department of the Royal Navy, and detailed work on the design of a shore-based prototype is reported to be well advanced. Some orders for the machinery have already been placed.

Man-Made Substance Is As Hard As Diamond

General Electric's high temperature high pressure program, whose first product was a synthetic diamond, has turned out another material with a hardness equal to that of a diamond (February 1955). Called Borazon, the substance is the cubic form of boron nitride, and is just one more of many materials GE hopes to make for the high temperature field.

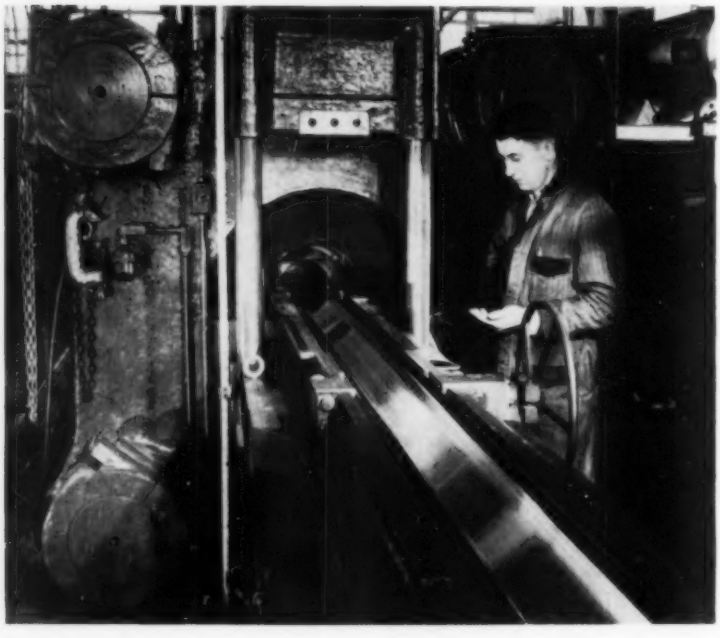
As it stands now, borazon will scratch a diamond, and a diamond will scratch a piece of borazon. The big difference, however, is that diamond, being basically carbon will burn up quickly in air at 1600 F, while borazon is unaffected at 3500 F.

Although far from the purchasable product stage, GE believes that borazon's resistance to oxidation will make possible better methods of mounting such materials in industrial tools, and may allow tool bits and wheels to be operated at higher speeds. As the industrial diamonds used for cutting tools come from Africa, GE hopes that the successful production of borazon will cut the strategic value of the diamond. GE is hopeful that borazon can be produced at a competitive price.

X-ray diffraction tests of borazon show that the alternate atoms of boron and nitrogen are packed together almost as closely as the carbon atoms in diamond. The density also is about the same—specific gravity: 3.45 for borazon and 3.50 to 3.56 for diamond. In lapping tests, borazon powder ground away a measured diamond as rapidly as diamond powder. Although the individual crystals of borazon usually are small—about $\frac{1}{32}$ in.—some crystals grow together to form strong lumps about as big as the eraser on a pencil.

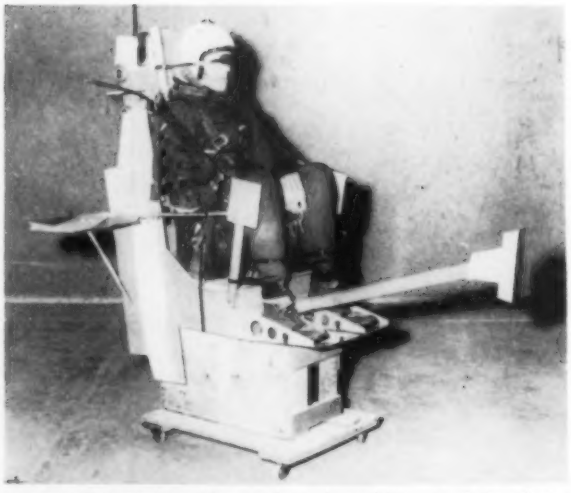
DR. R. H. WENTORF, of GE's Research Lab., and discoverer of borazon, is shown scratching a diamond with a piece of borazon. Enlarged view at left shows the scratches made. Models show atomic structure of boron nitride (borazon), top, left, and the diamond (top, right), Borazon has alternating atoms of boron (black) and nitrogen packed together almost as closely as the carbon atoms in the diamond. In ordinary boron nitride (bottom, left) the structure is hexagonal and the atoms are spaced farther apart. Ordinary boron nitride is similar to graphite (bottom, right) the hexagonal form of carbon.

THE NEWS IN PICTURES

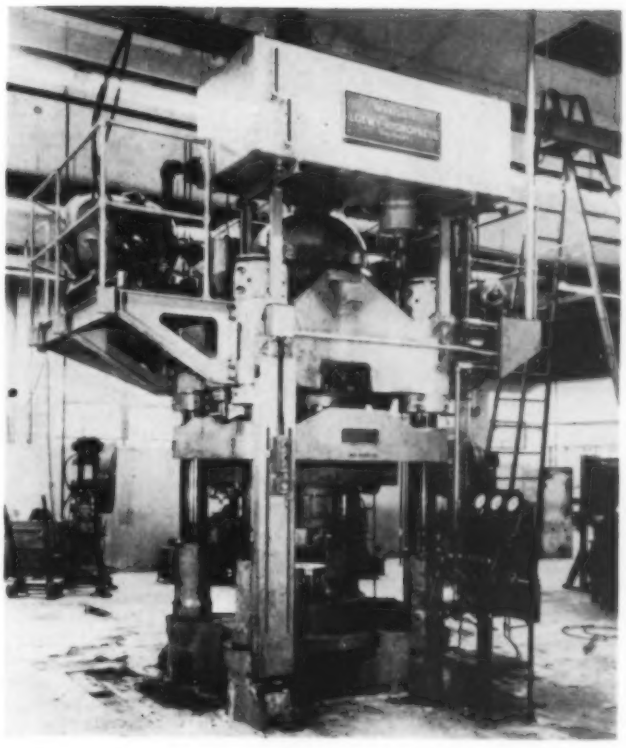


PALLET EXTRUSION, a new extrusion process developed by Dow Chemical Co., Madison, Ill., is being used to make stronger magnesium extrusions for military aircraft and missiles. To get these stronger sections, minute magnesium particles, rather than conventional solid billets are fed into the extrusion press. Then the particles are forced through a die under heat and pressure, just like the billets. The pellets are extruded into shapes with guaranteed compressive yield strength (cys) of 35,000 psi in cross-sectional areas up to 10 sq in.—as much as 40% higher than sections extruded conventionally. An 11 in. I-beam has a compressive yield strength of 42,000 psi with the pellet material compared to 30,000 psi with billet material; a 4 in. x 4 in. x $\frac{5}{8}$ in. angle has a cys of 38,000 psi with pellet material compared to 27,000 psi with billet material. Pellet extrusions have a higher cys because magnesium's strength is inversely proportional to its grain size. The pellets are spherical, about 0.016 in. in dia, can be extruded into sections with fine grain size. Dow says that the success of the process depends greatly on the new method of making pellet material from the molten magnesium alloy ZK60XB.

A BOON TO harried airline travellers is this pre-loaded luggage bin about to be lifted to the baggage compartment level of the mock fuselage of the Lockheed Electra propjet transport. Twenty seconds later, the bin will have been pulled by conveyor chain to the rear of the cargo compartment. The new system is designed to load or unload a complete set of four bins of scratch-free, dry, luggage in four minutes. The bin is made of fiberglass, measures 36 in. wide, 77 in. long, 24 in. deep, and weighs 55 lb empty. Designed for pre-loading at the ticket counter, it is rolled to the plane on a dolly and is raised to the plane by an electrically powered, cantilevered hoist.



A PILOT'S SEAT with aerodynamic stability is designed to permit a safe escape from combat aircraft traveling more than 1500 mph at stratospheric heights, or as low as 400 ft at 850 mph. Designed by Lockheed Aircraft Corp., Burbank, Calif., and undergoing tests at the Air Research and Development Command's rocket sled test site, the parachute equipped seat has vertical fins which extend along each side of the seat's back, stubby wings, and an 8 x 5 in. steel plate wind deflector mounted on a 4 ft boom. In a bailout at 1500 mph at 30,000 ft, the new seat will reduce by 50 per cent the "G" load encountered in a conventional ejection seat, and eliminate the tumbling effects. Immediately upon clearing the plane the wind deflector telescopes forward and the seat's side vanes (8 in. long) swing open. The seat will then fly in a stable position until the chute opens automatically at a predetermined altitude (below 300 knots).



RADIOACTIVE MATERIALS are formed on this multi-purpose Marform press built for the AEC by the Loewy-Hydropress Div. of Baldwin-Lima-Hamilton Corp. The machine combines the Guerin rubber-pad process with conventional steel-die forming, whereby the male die is made of steel, but a rubber pad replaces the female die. The press will be operated in an airtight chamber of stainless steel and lucite to guard against contamination. Long rubber gloves will be built into the shield to permit manual operation within the chamber.

THE FIRST TIRE VULCANIZED by nuclear radiation is checked at the B. F. Goodrich Co., Akron, Ohio. Encased in a steel mold, the tire is rotated slowly over radioactive fuel elements in 17 ft of water. No sulphur or accelerators, standard materials of conventional vulcanization, were used, and the tire is expected to wear longer and resist deterioration better. The nuclear vulcanization resulted in a direct linkage of the carbon atom chains of the rubber molecules. Ordinarily, the carbon atom chains are linked through sulphur atoms. If the process becomes economically practical, the tires could be vulcanized cold on a production basis more rapidly than with the conventional processes which require 300-plus degrees. In commercial production, vulcanization could be done in a cell with radiation supplied by machines, or by radioactive by-products from a nuclear reactor.

TECHNICAL NEWS

SOON TO BE INTRODUCED in this country is the Unimog a multi-purpose industrial and agricultural vehicle designed by the Mercedes-Benz Co., of Germany. The vehicle's six forward speeds range from 0.6 to 31 mph, plus two crawling gears with speeds from 0.1 to 1.2 mph, and two reverse gears. With its rigid, raised type, double reduction portal axles with spur gears at the wheels, high ground and crop clearance (18 in.) is possible in spite of the small wheel. Shifting from rear wheel to 4-wheel drive and to the locking of the differentials is accomplished in full motion without the use of a clutch. The engine is a 25 hp 4-cylinder diesel with a Bosch fuel injection system. Wheel track normal front and rear, 50 in.; with wheels reversed, 57 in. Overall length is 140 in. Special equipment can be used with its front and rear power take-offs, belt pulley drive, front and rear power lift, and compressed air system.

Detroit News Notes....

A major chassis change is in the offing in the automotive industry in the not too distant future. Now in the experimental stage in most of the factories are bodies with the "unitized" or "integral" type of design. Production probably will be in 1960-61.

The reasons for the change are mostly financial. The automobile people prefer a three-year body change cycle, but even on a three-year cycle the tooling expense is great. Integral construction could cut some of that expense. This type of construction also permits greater use of decorative anodized aluminums, plastics, and other lightweight materials. To underline this coming change, Cadillac went to an X-type frame this year. Chevrolet and Pontiac will follow suit with a similar-type frame for their 1958 models.

Other changes. Chrysler, among others, is experimenting with a transmission back on the rear axle. This would make necessary a split rear axle, using a form of independent suspension for rear wheels—perhaps air suspension or air/oil suspension. Air suspension will be on the Cadillac Brougham; Lincoln is scheduled for it; perhaps the Thunderbird as well as another Ford car. Chevrolet will offer air suspension as an option.

Gas turbine. It is generally agreed that the gas turbine will first appear in trucks, but no one knows when. Also generally agreed: metals are no longer a problem in the turbine field. No cobalt and very little nickel will be required. Investment casting seems to be the method most favored for mass production of turbine wheels.

The biggest obstacle to the use of turbines in the immediate future is the huge investment in production facilities for piston engines. It will take several years to amortize that sum. However, one production expert says that what really is needed is a new look at retooling. This person claims that the tooling as well as the design people are generally hidebound, and cannot see anything but buy-everything - new - install - new - expensive - machinery.

A Small Country Plans Big In The Nuclear Field

Belgium has its sights set on becoming one of the world leaders in the nuclear energy field. With key elements of the government and industry working together, they intend to supply technology, fuel and other components to other European countries as well as the construction of nuclear installations in their own country.

One of the world's most heavily industrialized nations, Belgium also is in the enviable position of having in the Congo some of the richest uranium ore in the world. Because these deposits were made available to the free world, during and after World War II, Belgium now has access to information and technology not generally shared in Europe. Through its bilateral agreement with the U. S., Belgium has been invited to visit and study the various power reactor programs being carried out by the AEC, and is taking advantage of the extensive research programs under way in the U. S. Belgian scientists and engineers are also being sent to the U. S. for training in major nuclear centers.

Various government-industry groups in the nuclear field have been organized to hold the duplication of effort to a minimum. The reactor is charged with building a laboratory at Mol, where reactor development work, and research on fuel production and reprocessing is being carried out. A reactor similar to that at Brookhaven Lab is in operation at Mol.

Fifteen of the major electrical utilities are preparing the electrical companies for the coming of nuclear power. The four major holding companies are acting as consultants. Another group has been formed to design and build reactors, fabricate fuel elements, process irradiated fuels, and apply radioisotopes to industrial proc esses. It is interesting to note that in the U. S., ownership of the fuels is retained by the government, and is loaned to private companies. Belgium has no such regulation.

Belgium's plan calls for one power reactor every three years between 1958 and 1968, and one new power reactor every two years thereafter.

COMING EVENTS

APRIL 9-10

First Annual Conference on Electronics in Industry, Illinois Institute of Technology, Chicago, Ill. Sponsored by the IRE Professional Group on Industrial Electronics, and the Armour Research Foundation. Some of the papers will be: Economic and Technical Aspects of Industrial Electronics; Principles and Techniques for Direct Reading Digital Transducers; Application of Magnetic Amplifiers in Industrial Instrumentation and Control; Automatic Card Programmed Control of Reversing Rolling Mills; Solid State Devices in Industrial Electronics; Selection of Reliability Levels in Equipment Design.

APRIL 11-13

Southwestern IRE Conference and Electronics Show, Shamrock Hilton Hotel, Houston, Texas.

APRIL 14-16

National Symposium on Telemetering and Exhibits, Sheraton Hotel, Philadelphia, Pa.

APRIL 14-27

United States World Trade Fair, Coliseum, New York City.

APRIL 16-17

Conference on High Temperature Materials for Use in Aircraft, Missiles and Nuclear Reactors, Hotel Carter, Cleveland, Ohio. Sponsored by the Cleveland section of the American Institute of Mining Metallurgical and Petroleum Engineers, the papers will take up the present status of the development, basis of strength, problems and shortcomings and the future of each class of materials. The effect of vacuum melting and testing environment on high temperature properties will be discussed.

APRIL 24-25

Second National Research Conference, Conrad Hilton Hotel, Chicago, Ill. Sponsored by Armour Research Foundation of Illinois Institute of Technology, nine papers will be presented at three general sessions on: Sales Growth Through Research; More Research for the Dollar; Extra Dividends from Research.

APRIL 29-MAY 3

Seventh National Materials Handling Exposition, Convention Hall, Philadelphia, Pa. Concurrently with the show, the American Material Handling Society will conduct a conference to discuss new developments in handling methods. About 250 exhibitors are expected to have booths, showing more than 100 different types of materials handling equipment.

APRIL 30-MAY 1

13th Annual Meeting and the 1957 Metal Powder Show, Drake Hotel, Chicago, Ill. Theme of the meeting will be "New Horizons in Powder Metallurgy."

MAY 1-3

Society for Experimental Stress Analysis, 1957 Spring Meeting and Exhibit, Hotel Statler, Boston, Mass. For further information, contact: Dr. W. M. Murray, Sec.-Treasurer, P. O. Box 168, Cambridge 39, Mass.

MAY 6-10

1st Engineered Castings Show, Music Hall, Cincinnati, Ohio. Sponsored by the American Foundrymen's Society, the show will be run simultaneously with the 61st AFS Castings Congress. The show will feature a strong supporting program of technical sessions pointed toward the interests of product design engineers and users of cast products. Exhibits are being limited to: companies producing metal castings for sale; manufacturers of laboratory equipment for testing and quality control; producers of metals and alloys contributing to castings quality; companies producing patterns for sale. Sessions will be on methods and techniques for manufacturing engineered castings for the original equipment market.

MAY 8-11

Fluid Control Institute Meeting, The Greenbriar, White Sulphur Springs, West Virginia.

MAY 9-10

Annual Meeting of the IRE Professional Group on Microwave Theory and Technique, Western Union Auditoriums, New York City.

MAY 9-10

Pacific Northwest Instrumentation and Automation Exhibit, Seattle, Wash. The exhibit will be sponsored by the Seattle section of the ISA.

MAY 14-16

Second Annual Industrial Nuclear Technology Conference, Museum of Science and Industry, Chicago, Ill. The event will be sponsored by the Armour Research Foundation of the Illinois Institute of Technology, and **Nucleonics** magazine.

MAY 20-22

Northeast Region Spring Conference, Syracuse University, and the Hotel Syracuse, in Syracuse, N. Y. The conference will be on Corrosion Control by choice of Materials. Sponsors are the Central New York section of the National Association of Corrosion Engineers, and Syracuse University.

MAY 20-23

Second Design Engineering Show and Conference, the Coliseum, New York City. At least 375 exhibitors are scheduled to have booths for the display of products, components and materials of particular interest to the designer. The annual Design Conference is sponsored by the Machine Design Division of the ASME. For further information on the conference schedule, see page 185 this issue.

JUNE 2-5

41st Annual Meeting of the American Gear Manufacturers Association, The Homestead Hotel, Hot Springs, Va.

JUNE 6-7

First National Symposium on Production Techniques, Hotel Willard, Washington, D. C. There will be a panel discussion on "How to Prepare for and Implement Automation," which will be an over-all look at the problems that faced the present users in implementing an automation program. Another panel discussion will be on "Military Problems in Electronic Automation." The military problems will be discussed by representatives of the military and governmental agencies. Another session will be devoted to "Designs for Production," and papers are invited from engineers.

A Progress Report on Faculty Salaries:

UP...But Not Nearly Enough

THE CHART on this page provides a report of the progress being made in solving a problem of crucial importance to every American. The problem is that of seeing that college and university faculty members get decent salaries.

This new chapter, which brings the story forward two years—from 1954, when it was last dealt with in this series of editorials, through 1956—has a decidedly cheering element. For in the last two years faculty salaries have made real headway.

Two Years of Improvement

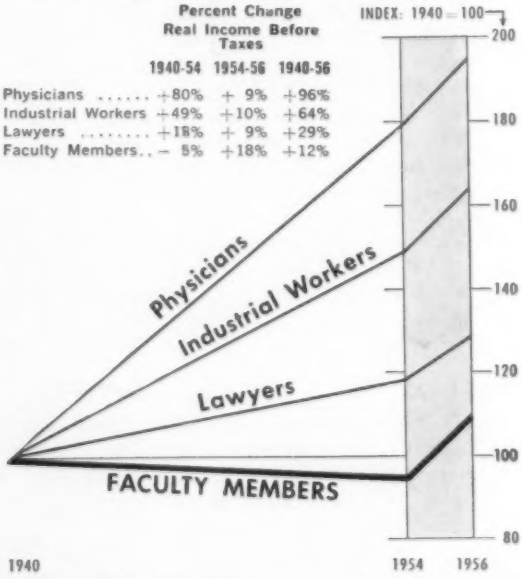
In 1954, in terms of what their salaries would buy, faculty members as a whole were actually worse off, by 5%, than they had been fourteen years earlier. As the chart shows, over the same period the real income of the average industrial worker had increased by almost half. And, in what it would buy, the income of the average physician, with professional training comparable to that of the average faculty member, had jumped by 80%.

In 1956, however, the average faculty salary would buy about 12% more of goods and services than it would in 1940. Relative to where they were two years before, faculty salaries showed a larger gain over the two years than those of any of the other groups whose salary progress is charted.

This movement of faculty salaries in the right direction has many contributing causes. The biggest single boost was given by the great Ford Foundation gift of half a billion dollars to our colleges, universities, and hospitals, almost half of which was ear-marked for faculty salary increases. Gifts from business firms have also

What is Happening to College Faculty Salaries

	Percent Change Real Income Before Taxes		
	1940-54	1954-56	1940-56
Physicians	+80%	+ 9%	+96%
Industrial Workers	+49%	+10%	+64%
Lawyers	+18%	+ 9%	+29%
Faculty Members	− 5%	+18%	+12%



DATA: Council for Financial Aid to Education, U. S. Dept. of Commerce, U. S. Dept. of Labor, National Association of Education Research Dept., McGraw-Hill Dept. of Economics.

helped a lot. And so, in many cases, have stepped-up money-raising campaigns by alumni groups and cooperative regional and state groups of colleges.

Still a Long Way to Go

However, faculty salaries started their ascent from such a dismal depth that they still have a long, long way to go up before there is room for the comfortable conviction that they are fair, or even safe, from the standpoint of protecting the nation's vital interests. It still remains possible to find many shocking companion pieces for the following incident recently reported to a McGraw-Hill executive group, working on problems of financial aid to higher education, by the president of an illustrious small liberal arts college.

"The recruiting officer of one of our large industrial companies came to our campus a few weeks ago," the college president said, "and offered five of our seniors higher salaries to start working for that company when they are graduated next June than the salary received by any member of our faculty. And the seniors, of course, promptly went to their professors to seek advice on whether or not they should accept. It doesn't take much imagination to see what this sort of thing does to the morale of a faculty."

Senior Teachers Fare Badly

One of the more devastating things it does, of course, is to make the more experienced college and university faculty members receptive to the idea of going to greener pastures, currency-wise, in business and industry.

For these senior faculty members the financial pounding in the past 16 years has been even worse than the chart indicates. While the average real salary gain reported by the chart has been 12%, the average salary of a full professor still buys less than it did in 1940. This is because most of the salary increases have gone to beginning instructors, for whose services industry has been providing the sort of competition reported by the liberal arts college president.

And it creates this financial lackluster of posts as senior college faculty members right at the time their services are needed more than ever to handle the oncoming flood of college and university students. Between now and 1970 college and university enrollment is expected to double.

What is Needed Now

What is clearly needed is a continuation and intensification of the drive to increase their salaries to a point where college and university faculty members will be sharing somewhere near fully in the general prosperity of the nation. It could be counted good progress in this direction if over the next two years faculty salaries on the average were to go up another 12%, with most of the increase concentrated in the senior faculty ranks. And this can be made possible only through more outside contributions.

There is reason to be encouraged by the progress that has been made over the past two years in bailing college and university faculty members out of the terrible financial hole into which they were allowed to slide. But there is the most urgent occasion to keep at it and harder.

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Donald C. McGraw

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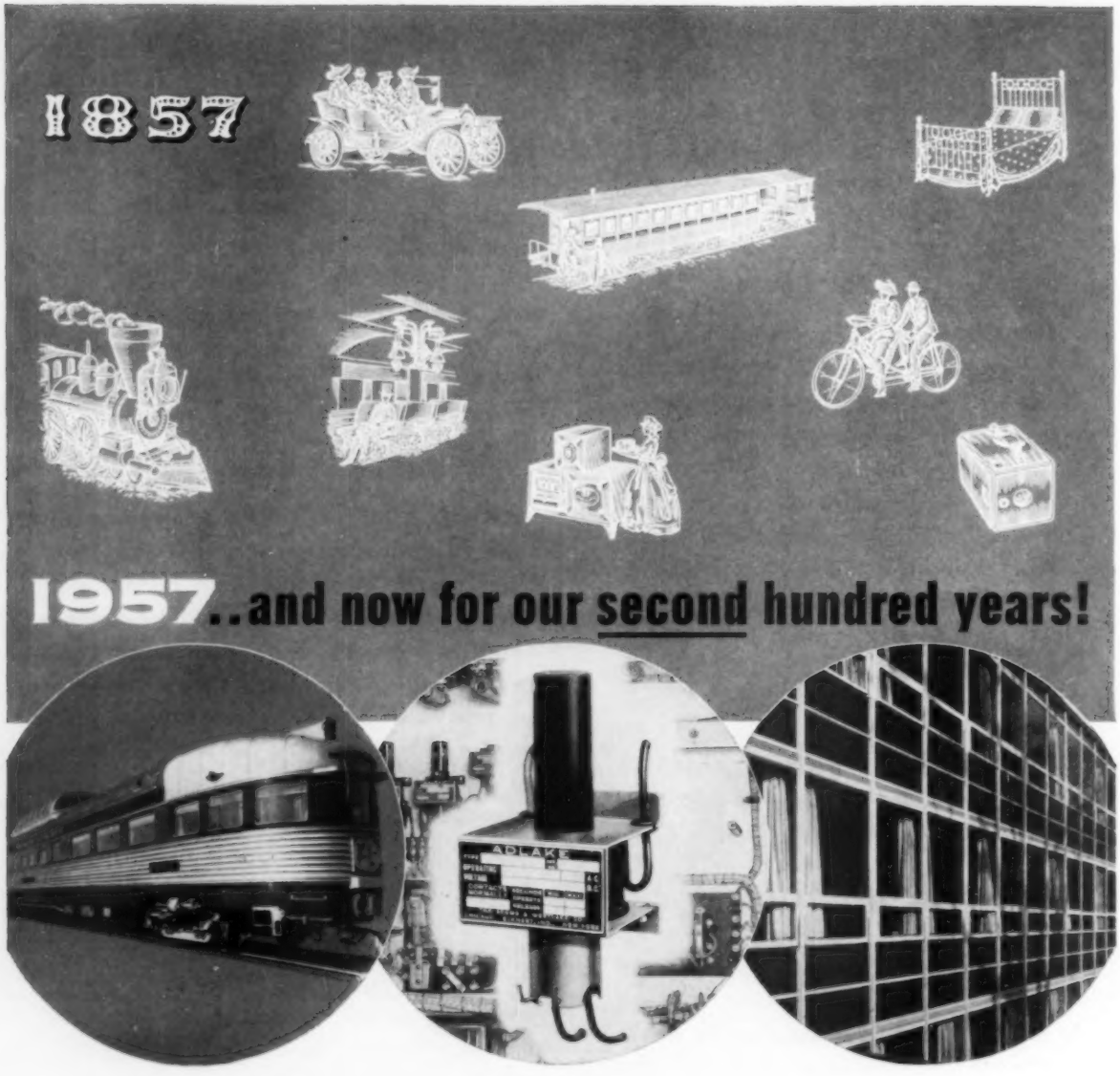
Product Engineering reference book sheet



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How to Find Thickness of A Constant-Stress Disk

J. H. ROWE, *Aircraft Gas Turbine Division, General Electric Corp.*

Symbols

A = cross section of mass attached to rim, in.²
g = acceleration due to gravity, 386 in./sec²
L = length of attached rim mass, in.
n = number of turbine blades
P = rim load, lb/in. of circumference
r = radius at any point, in.
r_r = radius from center of rotation to base of attached rim mass, in.
r_g = radius from center of rotation to center of gravity of flywheel rim, in.
t = disk thickness, in.
ω = disk or wheel speed, radians/sec
p = material density, lb/in.
σ = design stress, psi
σ_r = free hoop stress, psi

IF a wheel or disk has a constant thickness, the stresses during rotation are not evenly distributed—the higher stresses being concentrated at the center of the member. Problem of designing for constant stress distribution often occurs in the design of flywheels, large gear wheels, steam and gas turbines and axial flow compressors.

Solution is to design the disk with a varying section. This keeps the stresses constant throughout the disk and may save material by removing it from sections which increase centrifugal forces without adding to the strength of the rim.

Computing the varying thickness of the disk involves mathematical analysis which can be avoided by using the two design charts in Figs. 1 and 2. First step is to determine the rim load carried by the disk, such as gear teeth or turbine blades. For turbine blades, the rim load is calculated from

$$P = n\left(\frac{r_r + L}{4}\right)\left(\frac{L\,A\,p\,\omega^2}{2\,\pi\,r_r\,g}\right)$$

Once the rim load is known, next step is to compute free hoop stress from the equation

$$\sigma_r = \frac{\rho\, r_r\, \omega^2}{g}$$

Free hoop stress is an imaginary stress which would exist in a hoop rotating at the wheel speed and having the same diameter as the rim. In Fig. 2, this stress is plotted against radius for various values of ω. To find the free hoop stress it is only necessary to know the radius and speed of rotation. The mass density used for this chart, 0.3 lb/in.³, is approximately true for most nickel steels.

Example

A wheel with 12 in. radius ($r_r = 12$) is to rotate at a speed of $\omega = 600$ rad/min. Allowable stress is 20,000 psi; rim load is 5000 lb/in. of circumference. Find the thickness at $r = 3$ in., 6 in., and 9 in., where r is the distance from the center of the wheel as illustrated in Fig. 1.

From Fig. 2 for $\omega = 600$ and $r_r = 12$, $\sigma_R = 40{,}000$ psi. Therefore the ratio $\sigma_R/\omega = 40{,}000/20{,}000 = 2$. Ratios of r/r_r are 3/12, 6/12, 9/12, or in

(continued on page 213)

Derivation of Method

Consider an element of volume in a variable thickness disk. By equating forces and letting $\sin d\theta/2$ equal $d\theta/2$:

$$\sigma_r\, t\, r\, d\theta + 2\,\sigma_t\, t\, dr\, d\theta/2 - \sigma_r\, t\, r\, d\theta - d\,(\sigma_r\, t\, r\, d\theta) - R = 0 \quad (1)$$

where $R = m\, r\omega^2$ and mass m is expressed as $m = \rho\, t\, dr\, r\, d\theta$. Performing the indicated operations in Eq (1) and letting $\partial/\partial_r\,(\partial\theta) = 0$, yields:

$$\sigma_t\, t - [\sigma_r\, r\, \partial t/\partial r + \sigma_r\, t\, \partial r/\partial r + t\, r\, \partial\sigma_r/\partial r] - \rho t\, r^2\, \omega^2 = 0 \quad (2)$$

The term in the brackets is identical to $d/dr\,(\sigma_r t\, r)$, therefore Eq (2) becomes

$$d/dr\,(\sigma_r\, t\, r) = t\,(\sigma_t - \rho\, r^2\, \omega^2) \quad (3)$$

For constant stress disk, $\sigma_r = \sigma_t = \sigma$, and $\partial\sigma_r/\partial_r = 0$. Substituting in Eq (3) and amplifying, yields

$$\sigma\, r\, \partial t/\partial r = -\, t\rho\, r^2\, \omega^2 \quad (4)$$

Since $\partial t/\partial r$ then equals dt/dr, Eq (4) may be written as a function of thickness

$$\frac{dt}{t} = \rho\,\frac{\omega^2}{\sigma}\, r\, dr \quad (5)$$

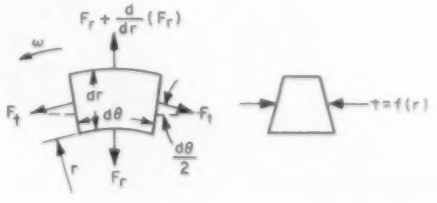
which integrates to

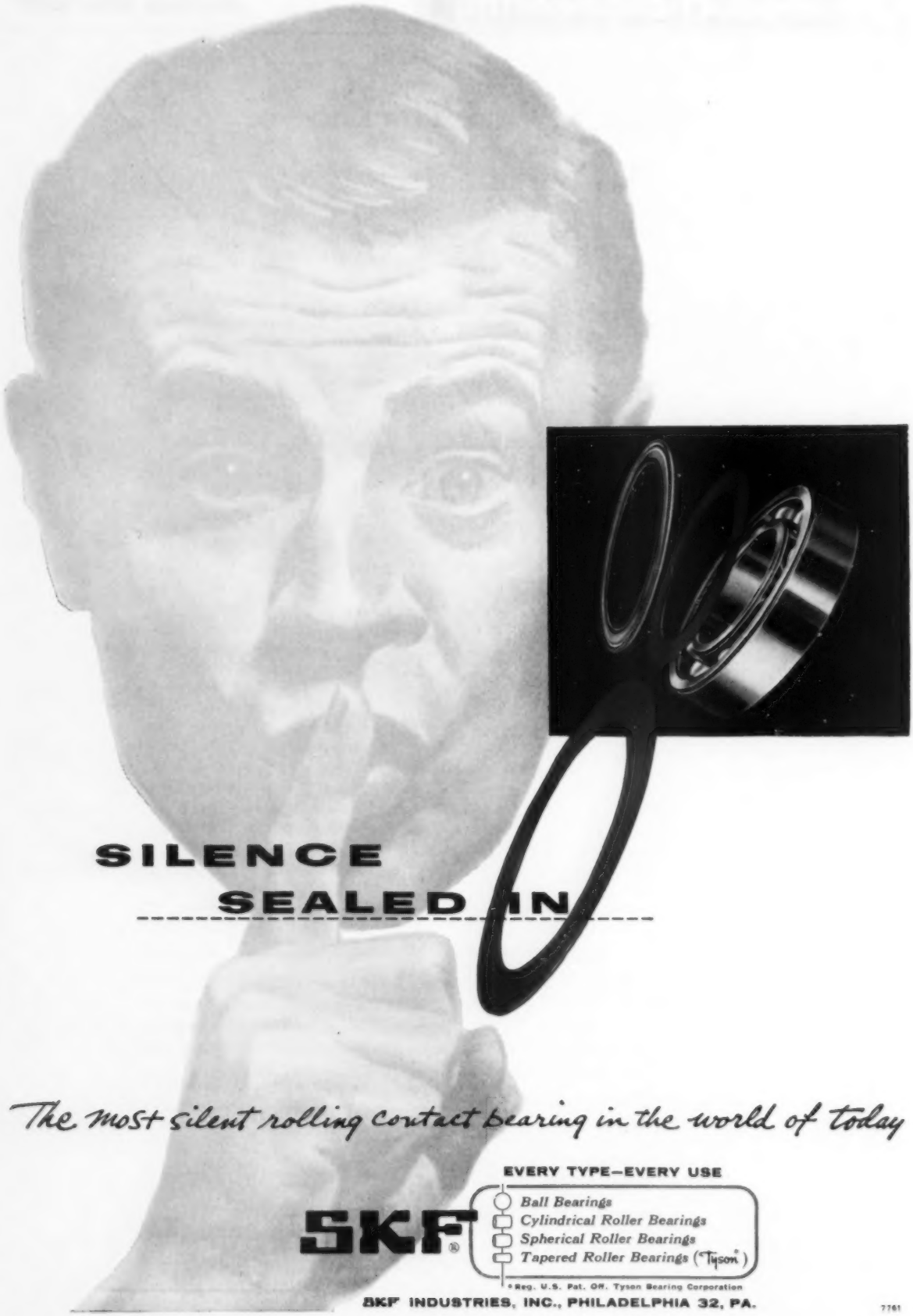
$$_{LN}\, t/t_r = (\rho\, \omega^2/2\,\sigma)\,(r_r^2 - r^2) \quad (6)$$

For constant stress disk, the rim thickness t_r is equal to the rim load P divided by the allowable stress σ; therefore, Eq (6) may be expressed as

$$_{LN}\, t\sigma/P = (-\,\rho\,\omega^2 r_r^2/2\sigma)\,(1 - r^2/r_r^2) \quad (7)$$

Thus a thickness parameter can be plotted, Fig. 1, in terms of the free hoop stress ($\rho\omega^2 r_r^2$), the design stress σ, and the radius ratio r/r_r.

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How to Find Thickness of a Constant-Stress Disk (continued from page 211)

decimals: 0.25, 0.50, 0.75. In each case enter chart, Fig. 1, at the r/r_r scale and project down to σ_R/σ ratio of 2. Read thickness factor, $t\sigma/P$ on left scale. Wheel thickness at radius equals thickness factor times rim load divided by allowable stress or

$$t = \left(\frac{t\sigma}{P}\right)\left(\frac{P}{\sigma}\right)$$

For radius of 3 in., thickness factor is 2.5, hence

$$t = \frac{(2.5)\ (5000)}{20{,}000} = 0.625 \text{ in. radius}$$

Similarly for 6 in. and 9 in. radii

$$t = \frac{(2.1)\ (5000)}{20{,}000} = 0.525 \text{ in. radius}$$

$$t = \frac{(1.5)\ (5000)}{20{,}000} = 0.375 \text{ in. radius}$$

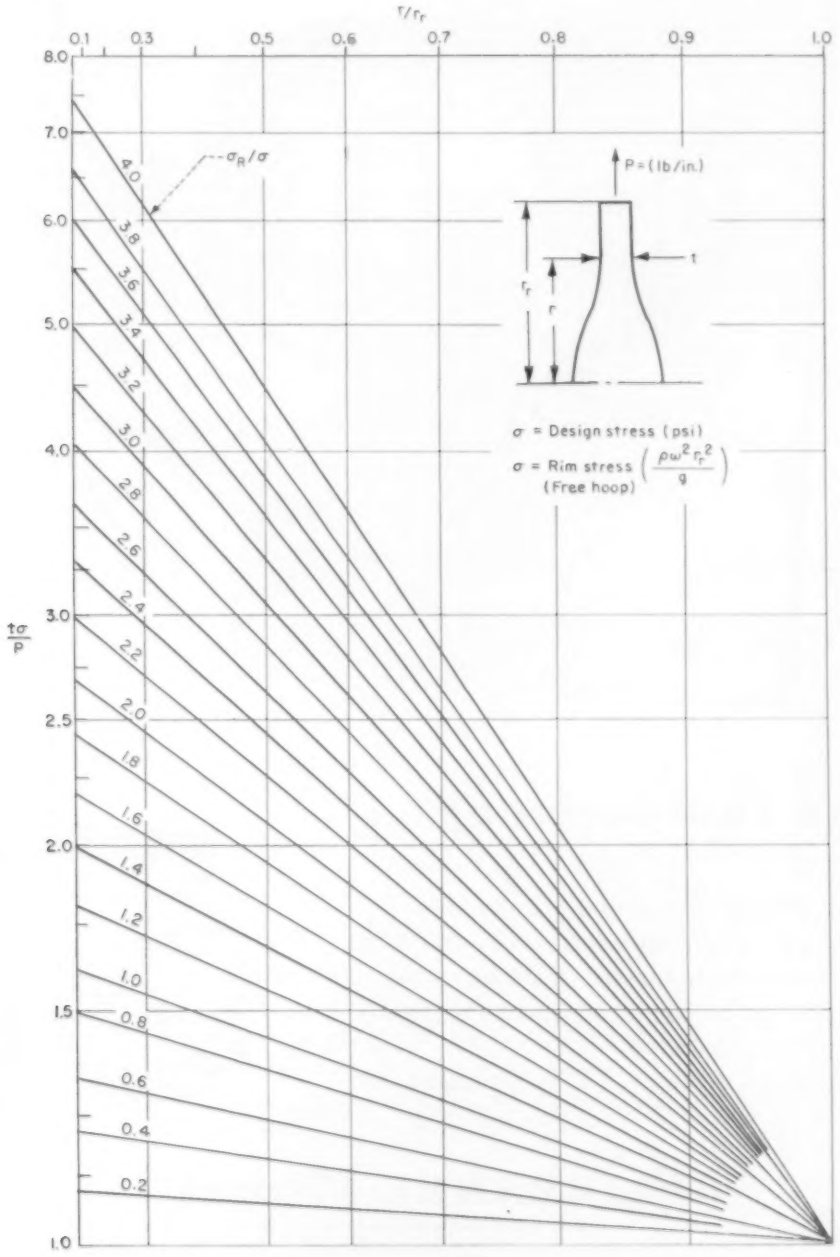
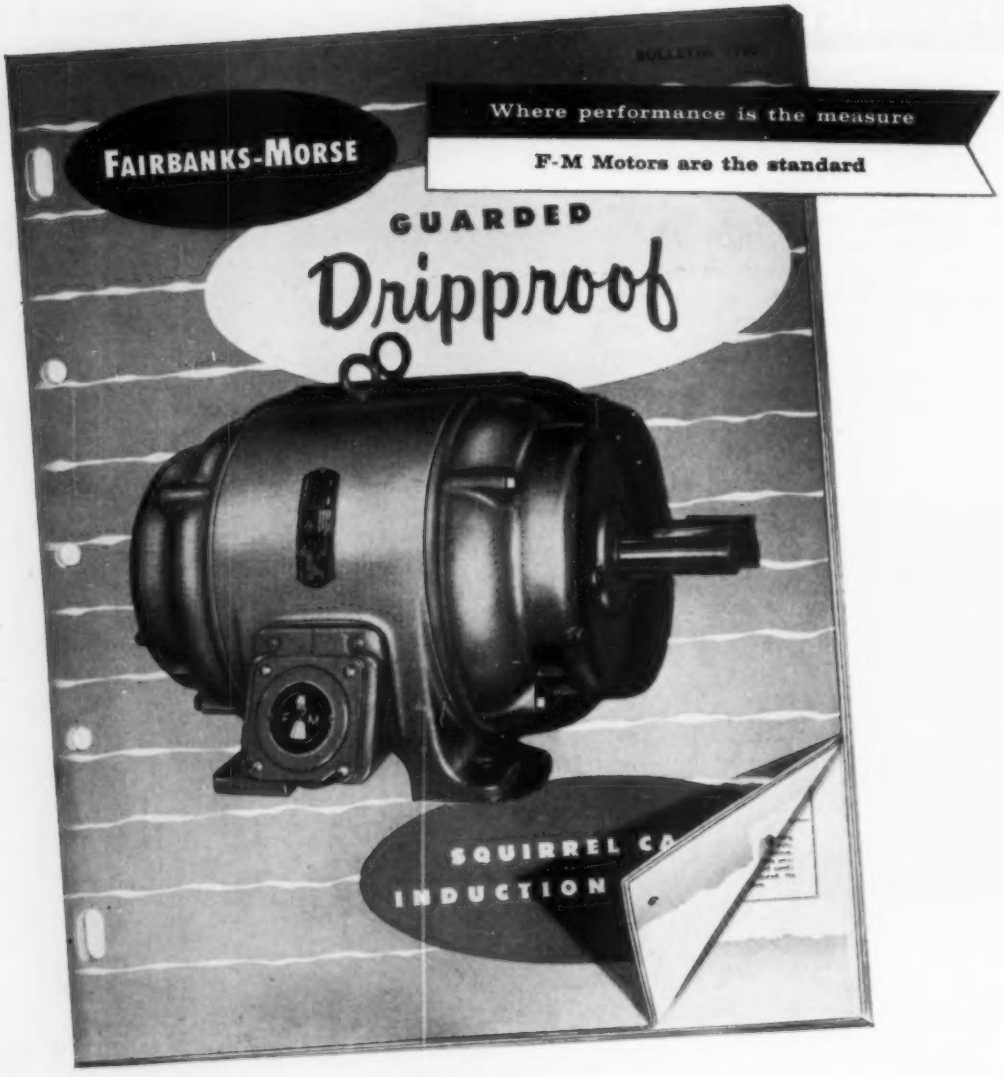


Fig. 1—Design chart for constant stress disks.

(continued on page 215)



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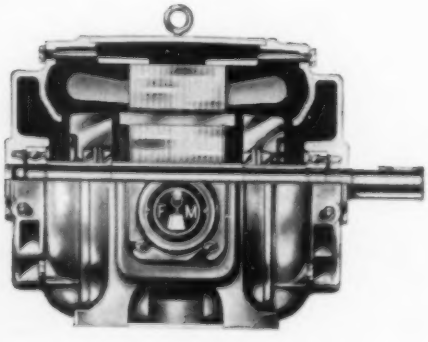

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How to Find Thickness of a Constant-Stress Disk (continued from page 213)

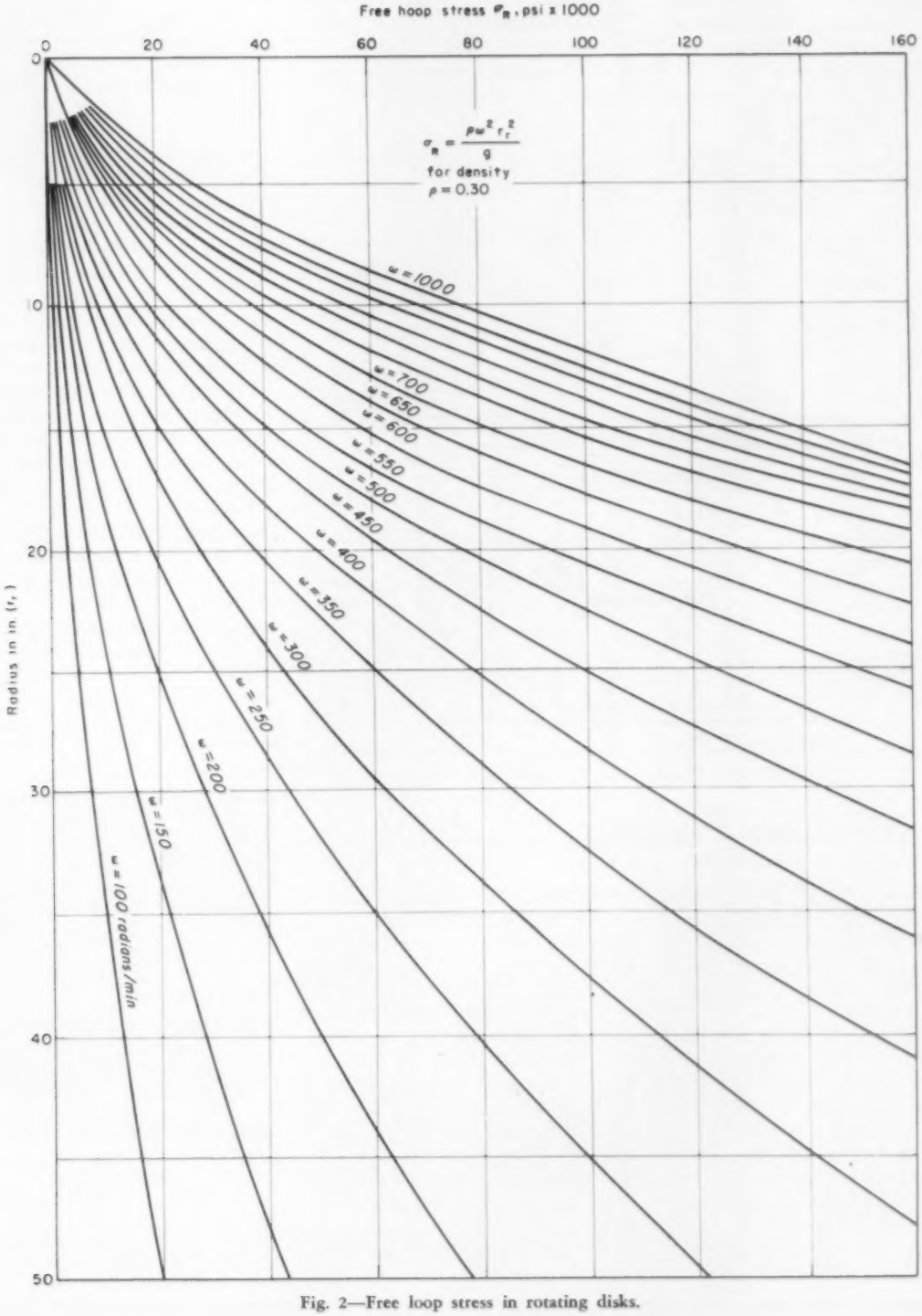
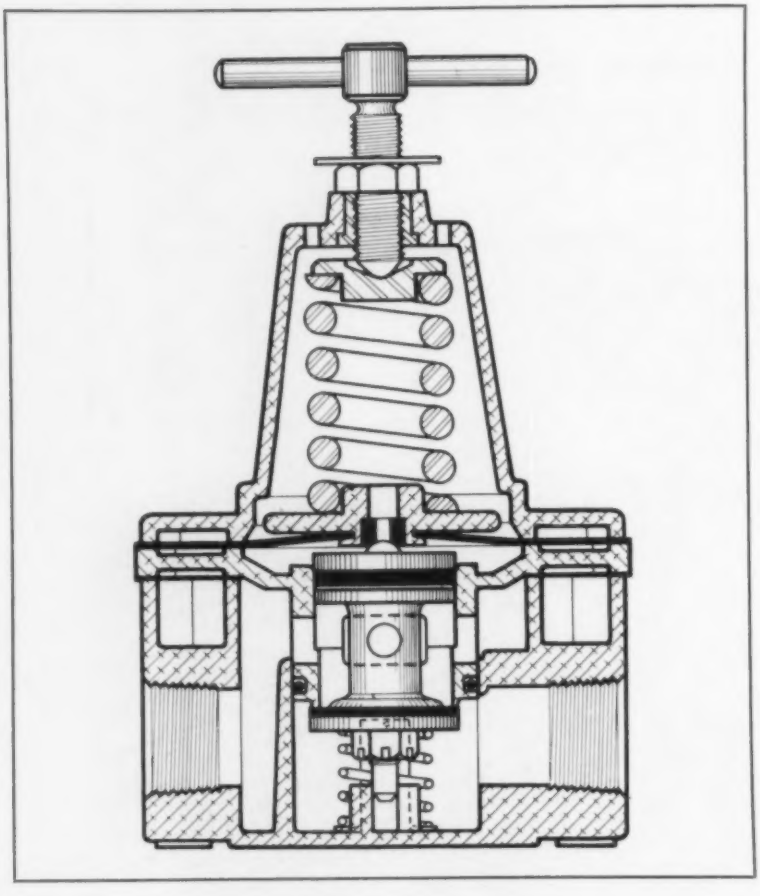


Fig. 2—Free loop stress in rotating disks.

NEW COMPONENTS



Air Line Pressure Regulator

A piston-balanced poppet valve (slightly unbalanced toward the closed position), is said to make possible the use of a much larger valve than in conventional regulators. This valve-piston member opens to full pipe capacity in a stroke made particularly short by its position in the air stream. The piston end is near the diaphragm, the valve away from it, and primary pressure is brought in between the two so that air flow is in the direction of valve opening, not against it.

This arrangement provides added stability and freedom from chatter, in all regulator sizes. It also places three of the four changes in direction of flow on the high-pressure side of the valve, where they are made at the least volume. The low-pressure, high-volume flow is almost straight-out as it leaves the valve. This results in a very small difference between secondary pressure as sensed at the regulator's own gage (which connects with the secondary pressure chamber) and pressure readings taken several diameters down the outflow pipe or tube. The straight-out flow also results in a valve seat that is permanently self-cleaning.

The new regulator holds controlled pressure settings within 2 lb when supply pressure drops as much as 50 lb. Sensitivity is completely independent of valve area.

Removing the regulator's bonnet makes it possible to lift off the diaphragm. A removable cartridge then lifts out, and with it the main valve and every internal part except the compensating spring and gage port shield, both of which can be lifted out next if desired. It is never necessary to remove the body casting from the line. The cartridge assembly that is removed can be taken apart and reconditioned, then stocked for insertion in the next regulator of that body size that may need attention.

The regulators are offered in three body sizes, each tapped for three pipe sizes, and they are available for all standard pipe sizes from $\frac{1}{4}$ to $1\frac{1}{4}$ in. The $\frac{1}{4}$ and 1 in. sizes are each offered in two different body sizes, the larger units being recommended for applications where maximum air flow capacity is particularly desirable. The standard spring for each model provides regulation all the way from 3 to 125 psi, from any primary pressure up to 250 psi. An alternate low-pressure spring provides somewhat higher flow and greater sensitivity in the secondary pressure range from $1\frac{1}{2}$ to 40 psi. All models are self-venting unless specifically ordered without the necessary venting feature. Hannifin Corporation, 501 S. Wolf Road, Des Plaines, Iowa.

For more information—
Circle 1, inside back cover

Motorized Variable Speed Reducer

A speed control providing stepless speeds from zero to 400 rpm consists of a variable reducer built onto a 48-frame, General Electric motor. The motor drives the reducer through 1:1 helical gears running in oil.

This package is $5\frac{3}{4}$ x $5\frac{5}{8}$ x $9\frac{3}{8}$ in. long, excluding shafts. Eight basic models delivering 10 to 30 in-lb

AND MATERIALS

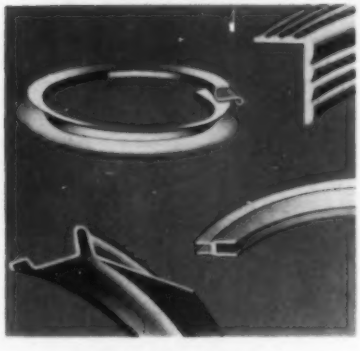
SPECIFIED BY PRODUCT ENGINEERS

torque, with clockwise or counter-clockwise output shaft rotation, are available.

Speed changes can be made with the control lever while the unit is running or stopped. It can be set at zero output speed with the motor running without excessive heating, or it can be run at one speed. A screw control is available for finer speed adjustment.

The standard motor used in this package is for 115 v, 60 cps, single-phase, of openframe, dripproof construction. It can be operated in any position. The unit is said to operate quietly and its maximum temperature rise is 50 C over ambient. Revco, Inc., 1900 Lyndale Ave., S., Minneapolis, Minn.

For more information—
Circle 2, inside back cover



Curved Plastic Extrusions

This manufacturer is said to have developed a technique which eliminates the necessity of post-forming extruded plastic molding. Undistorted, curved moldings are produced. The technique permits designers to specify simple or complex cross-sections of many thermoplastic materials in circles or sections of circles from 4 in. dia upward. Anchor Plastics Co., Inc., 36-36 36 St., Long Island City 6, N. Y.

For more information—
Circle 3, inside back cover

In-Line Digital Display

Digits 0 to 9 are 1¼ in. high and include a shifting decimal point. Units are also available with plus or minus and a-c and d-c characters. Lamp replacement when necessary is made at the rear of unit. All wiring is also located at the rear.

The displays may be purchased in single units and in groups of two or more. Bezel plates for single or group units will be available. Size of the screen is 1⅞ x 2 in. high. Voltage is 6 to 7.5 v a-c or d-c. Industrial Electronic Engineers, 3973 Lankershim Blvd., N. Hollywood, Calif.

For more information—
Circle 4, inside back cover

Electro-Mechanical Control System

The system consists of three components:

A) A displacement transducer capable of sensing displacement to ± 0.0003 in., and supplying a linearly varying 60 cps electrical signal of 4 microv per 0.001 in. sensitivity. It has built-in electrical switches for sensing both initial actuation and over-travel of the stylus.

B) An electronic amplifier, of the plug-in type, for providing power to a standard 60 cps, two-phase, servo motor-tachometer from the stylus signal, and tachometer feedback adjustment for system damping control. It incorporates a test switch for rapid in-place checking of the amplifier.

C) A mechanical power amplifier providing up to 1 hp of control output, using a low-level motor-tachometer as the input device. This component takes its power from a constantly revolving shaft (reference). The instant the servo motor is energized its torque speed characteristics are mechanically amplified and provide power to drive the load in accordance with the original sensing signal. With a closed loop control, the system constantly strives to reduce the sensing signal to zero.

All three components have been successfully employed on such machine tools as tracer lathes, where chip and coolant problems prohibit the use of too-delicate devices. Seneca Falls Machine Co., Seneca Falls, N. Y.

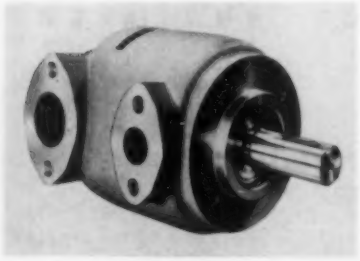
For more information—
Circle 5, inside back cover

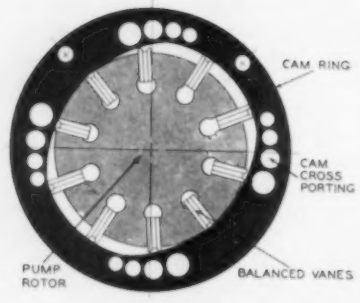
Vane Pump for 2000 Psi Service

Balanced vane hydraulic pumps supply rated deliveries of up to 100 gpm at speeds up to 1800 rpm. The pump is available with either clockwise or counter-clockwise shaft rotation. Shaft rotation is easily changed by indexing the cam ring to the dowel pin hole with the arrow indicating the desired direction of rotation.

The pump consists of a housing which provides an outlet connection, a bore for support of the shaft bearing and shaft assembly, and a larger bore which contains the floating pumping cartridge, consisting of a front port plate, vane, rotor and cam ring assembly and rear port plate with a shaft and support bearing. Two-bolt threaded flanges are provided as standard equipment but four-bolt hydraulic

CONTINUED ON PAGE 218





connections are available for those desiring to use SAE four-bolt split flange connectors. This pump may be face, foot or flange-mounted in any of four positions on its mounting bracket. The suction inlet port can be assembled in various selected positions with regard to the pressure delivery port. Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Road, Columbus 16, Ohio.

For more information—
Circle 6, inside back cover

Spherical Underlay Scale

This drafting accessory is an underlay which provides a finely divided grid of spherical coordinates (like latitude and longitude lines of geography). With this device, it is said to be possible to draw accurate, measured spherical space figures and solve problems in spherical geometry, theory of projection, trajectories, gyroscopics, mechanical motion.

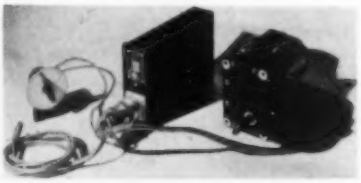
Foreshortening can be computed along isometric, dimetric or trimetric axes or along skew (non-isometric) lines without use of formulas or box constructions. The underlay provides scale, protractor, solver, ellipse guide.

Base sheet is an 8 x 10 in., hard-surfaced, multi-ply, coated Bristol board. Sphere is 5 in. dia. Instruction booklet is included. Sphere Grid Sales, 3829 Davis Pl., N.W., Washington 7, D. C.

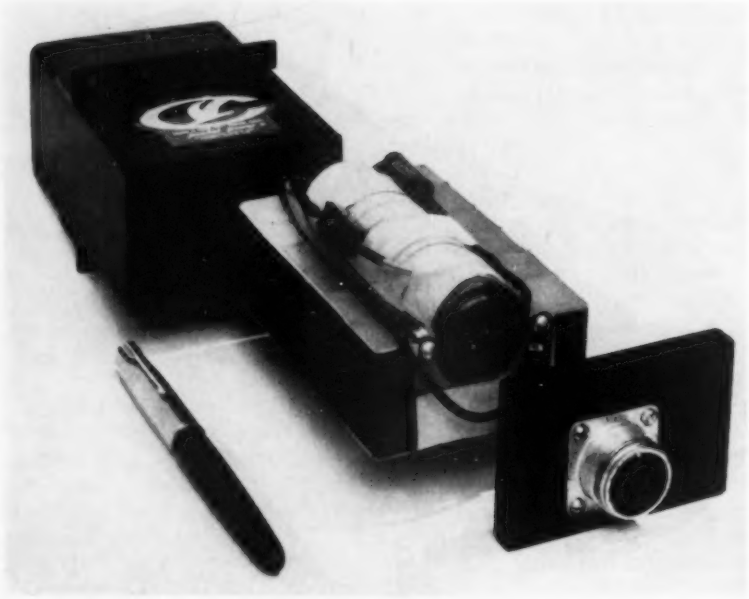
For more information—
Circle 7, inside back cover

Remote Positioner for 60 Cps Service

Originally developed in a 400-cps version for use in aircraft applications, this version is adapted to commercial power supply. The device weighs 16 lb and reaches maximum speed in 1/50 sec and is accurate within ½ deg.



The 60 cps model is similar to the 400 cps unit except that it has an integral generator. The three basic components are a data link, which converts manually-positioned input into error voltage; an amplifier, which processes signals from the data link and a velocity signal from the servo



Emergency Battery Power

This device is a silver-zinc battery having a very long shelf life. It is shipped in dry condition, but carries its own electrolyte supply inside the sealed case. In response to a momentary electrical signal, the fluid is transferred to the battery cells, producing full power output within ½ sec.

The unit shown produces 28 v at 700 w for 2 min. It weighs 1¾ lb, and measures 2⅛ x 3⅛ x 5 in. overall. Other models are available, including voltage outputs up to 500 v and current outputs up to 1000 amp.

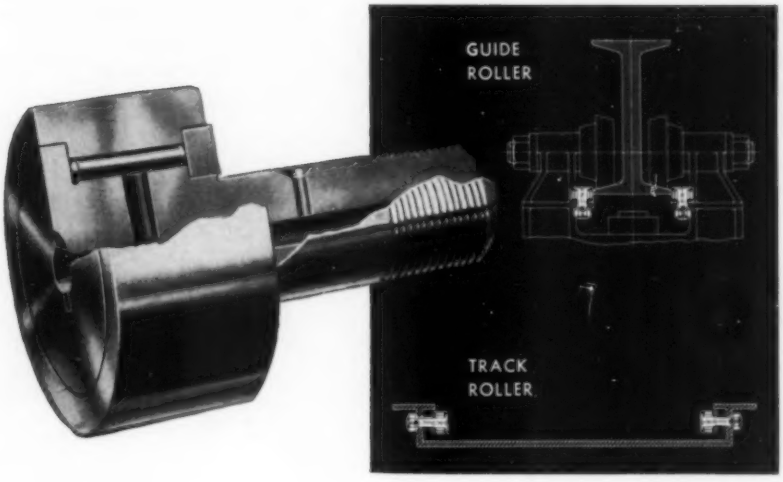
A double set of electrically-ignited gas generators produces all of the pressure required. No vacuum is used and no maintenance or adjustments are required. The battery is suited to emergency power requirements, coming into use when primary electric power fails. The battery operates at ambient temperatures between −65 and 240 F. Frank R. Cook Co., Electrochemical Div., 36 S. Sante Fe Dr., Denver 23, Colo.

For more information—
Circle 8, inside back cover

CONTINUED ON PAGE 220

BEARING TIPS by McGill

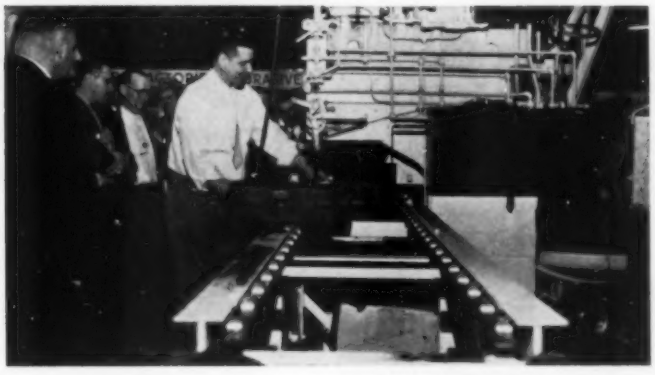
Let a CAMROL bearing be your guide



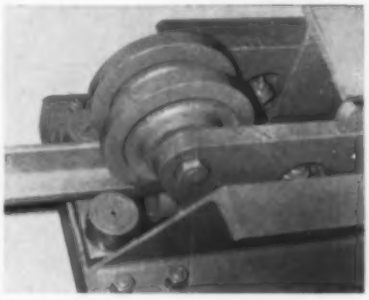
Obtain freer rolling, improved alignment and positive side thrust

In guide and support roller applications CAMROL Cam Followers insure free rolling action and positive side thrust while eliminating the wear of more costly flanged wheels. Then, too, they provide improved alignment and low starting and running friction with high unit load and shock capacity, especially at low speeds as track rollers. Lubrication is simplified and maintenance can be reduced to a minimum in these applications. Specify the interchangeable sealed SGR series for added protection against contamination.

CAMROL CF bearings provide friction-free track rollers for automatic mold blower



McGill CAMROL CF rollers are used as guide rollers to form a mold conveyor in the Beardsley & Piper MBS-20 Mold Blower. The machine blows and squeezes cope or drag in a single automatic operation, handling up to 4 molds per minute. The CAMROL CF bearings replaced less efficient friction rollers in this application. Although, the duty here is rather light and speeds slow, the cam follower bearing provides lesser starting and running friction. This helps speed the flow of work from the machine, which must be fast and automatic. The integral stud feature eases assembly and its standard design simplifies procurement.



CF bearings minimize maintenance as crane side guide rollers

McGill CF cam follower bearings serve as side guide rollers in overhead cranes manufactured by Louden Machinery Company of Fairfield, Iowa. Freedom from maintenance, a time saver because of the inaccessibility of the bearing when the crane is in operation, is an important advantage of the cam follower bearing.

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McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

drive; and the servo drive, which incorporates the integral generator and provides power output to the load.

The positioner uses a magnetic-powder clutch, which isolates the inertia of the servo's rotating components from the driven load. Torque-to-inertia ratio is said to be consequently high, increasing accuracy and response beyond the usual limits. Lear, Inc., Dept. 80, Grand Rapids 2, Mich.

For more information—
Circle 9, inside back cover

Battery of 0.44 In. Dia

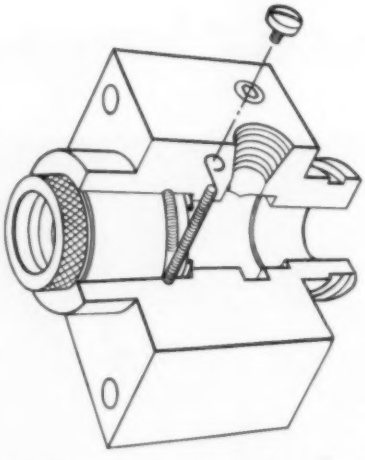
Weighing 1/20 oz, this battery measures 0.440 x $\frac{1}{8}$ in. thick. It is made exclusively of non-magnetic materials. Nominal voltage rating is 1.5 v, and it provides a total of 60 milliamp-hr, down to a cutoff voltage of 1.3 v. Top recommended average current drain is 60 microamp or less.

In the electric wrist watch for which it was developed, this is rated for continuous operation of more than a year. National Carbon Co., 30 E. 42 St., New York 17, N. Y.

For more information—
Circle 10, inside back cover

Quick-Change Cylinders

Rated at 250 psi for pneumatic use or up to 1000 psi for hydraulic, cylinders come in seven bore sizes, up to 6 in. The rod end of these cylinders uses a rod cartridge which is locked to the head by a stainless steel coil spring, seated in matching grooves in the head and cartridge. By

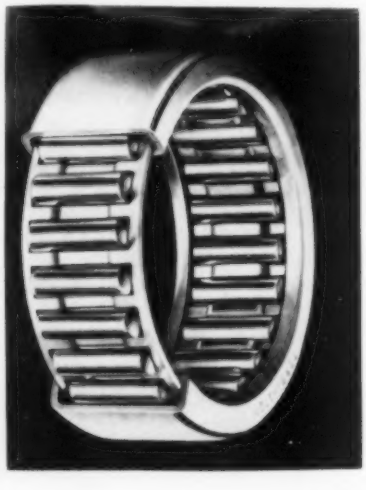


removing one screw, this spring can be stripped out and the cartridge removed. This allows the quick replacement of a worn rod seal or the rod cartridge itself, if necessary. The cylinders are designed and built to JIC recommendations with standardized mounting dimensions. Teer-Wickwire & Co., 1839 Wildwood Ave., Jackson, Mich.

For more information—
Circle 11, inside back cover

Roller Bearings with Drawn Cups

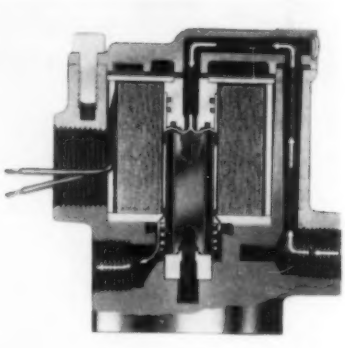
The turned in lips of the bearing cup, riding close to the shaft, are said to exclude dirt and grit. At the same time, they retain lubricant, which is circulated by the rollers



themselves to all bearing contact surfaces.

The bearings are made in six standard sizes, $\frac{7}{8}$ to $1\frac{1}{8}$ in. shaft diameters. Torrington Co., Torrington, Conn.

For more information—
Circle 12, inside back cover



Solenoid Pilot Units

The operating medium, carrying entrained lubricant, passes through the center of the solenoid, between the plunger tube and the plunger. This provides internal cooling, as well as continuous lubrication of the plunger, according to the manufacturer. The coil is encapsulated and completely sealed by multiple seals.

These pilots are suggested for handling air, vacuum, oil, water and inert gases, and are provided for direct, sub-base or manifold mounting. They are available in two and three-way types for separate pilot control applications.

Solenoid coils are supplied for 3 to 300 v d-c and 6 to 550 v a-c, 25 to 60 cps. Coil current consumption, at 115 v, 60 cps, is 0.2 amp. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 13, inside back cover

Clad Electrical Contact Tape

Contacts formed from electrical contact tape permit manufacture of contact assemblies by machine feeding the tape through the welding process.

CONTINUED ON PAGE 222

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN

Bridgeport Brass Co. Reporting New Developments in Copper-Brass Alloys and Metalworking Methods

Two Easily Machined Bridgeport Alloys That Offer Outstanding Advantages

by M. A. BUELL
Chief Staff Metallurgist

When everyday requirements call for dependable, fast-cutting rod, consideration should be given to two outstanding free-cutting alloys:

Bridgeport Alloy No. 6, the standard free-cutting brass rod, has exceptionally free-machining qualities. Containing 61% copper, 3.4% lead and 35.6% zinc, it has a uniform composition and can be finished to extremely close tolerances.

Bridgeport Tellurium Copper Alloy No. 112 offers unusually good machinability – 90 as compared to 100 for free-cutting brass Alloy No. 6 – but it also has extremely high electrical and thermal conductivity ratings as well as unusually high resistance to corrosion.

Tellurium Copper No. 112 is ideal for all types of electrical parts, welding torch and soldering iron tips, as well as any other heat- and electrical-conducting parts requiring considerable machining.

Comparative ratings of each alloy are given below.

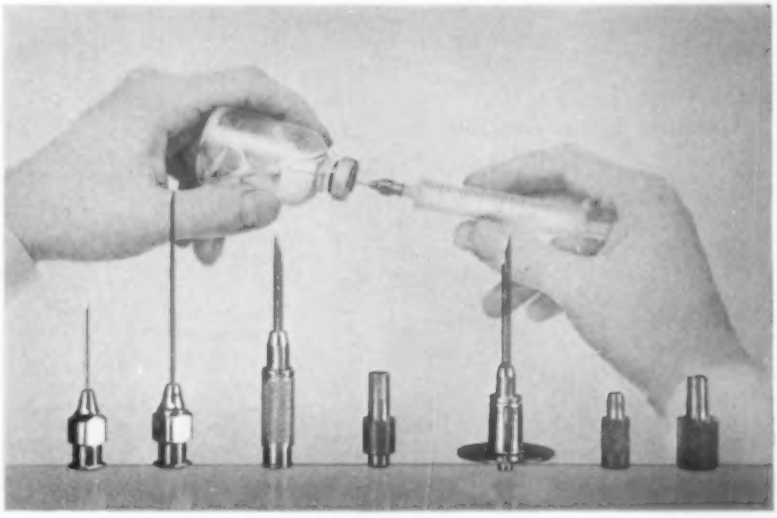
	Free-Machining Brass No. 6	Tellurium Copper No. 112
Thermal Conductivity*	67	204
Electrical Conductivity**	26	90
Machinability Rating	100	90
Cold-Working	Poor	Good
Hot-Working	Fair	Good
Hot-Working Range °F	1300-1450	1400-1600

*Btu/sq ft/ft/hr/°F @ 68° F
**% IACS @ 68° F Soft

Quick Way To Solve Your Metals Problems

Brass, copper and bronze alloys are all available in a widely varying range and combination of characteristics. Some are free-cutting, some have unusual ductility, others intrinsic hardness and still others high tensile strength. For best results, however, the metal should be matched to the job, both from the standpoint of machining as well as eventual product use. An easy way to get the answer to these questions is to talk over your metals selection problems with your Bridgeport salesman. Backed by Bridgeport's Technical Service, he can give you the finest possible help in solving your metals problem.

Free-Cutting Bridgeport Brass Plays Vital Role In Manufacture Of High-Precision Hypodermic Needles



Roehr Products Company, Inc., Waterbury, Connecticut, and Deland, Florida, manufactures over 1000 different types of hypodermic needles for every kind of medical and veterinary use. Each needle is designed and manufactured to high precision standards and to meet exacting tolerances on inside and outside diameters, finish and concentricity.

Hub Requirements

The hubs – an extremely important part of the needle from the point of view of exact fit – are made of Bridgeport Free-Machining Brass Rod, Alloy No. 6. Hub needle holes range from .018" to .085". Hubs are secured to the needles in a single press operation. In securing the needles to the hub it is imperative to avoid exerting excessive pressure – otherwise the needle walls would be pressed together and the needle would be constricted and useless. At the same time, the closure of the hub around the needle must be perfectly air- and liquid-tight. Each finished needle is tested under 45 pounds of pressure between the needle and the syringe.

Free-Machining Brass Is Versatile

The adaptability of Alloy No. 6 to the precise requirements of hypodermic needle manufacture is but another of the increasing number of jobs that this all-around alloy does so well. Its outstanding corrosion resistance is especially important in medical and pharmaceutical use. Its affinity for plating is another quality that governs its use in these instruments.

Wide Number of Uses

Many millions of needles are manufactured annually by Roehr—each must be flawless. Vaccine programs, blood banks, hospitals, doctors, veterinarians, research organizations, pharmaceutical houses – all must be sure that the needles they use are perfect in every respect.

Worth Investigating

Perhaps your present or future manufacturing or fabricating needs are not so exacting as Roehr's – perhaps they are more so. In either case, it will pay you to look into the impressive possibilities of Bridgeport Free-Machining Brass. Your Bridgeport salesman, with Bridgeport Technical Service behind him, will be glad to help. Call him.

BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Connecticut, Offices in Principal Cities
In Canada: Noranda Copper and Brass Limited, Montreal

Tape is pre-formed to finished shapes with close tolerance limits.

Contact material facings need not be any thicker than actually required for expected life, which saves metal according to the manufacturer. The tape is rolled to finished form and normally supplied with a serrated base metal backing to facilitate welding. Metals & Controls Corp., General Plate Div., Attleboro, Mass.

For more information—
Circle 14, inside back cover

Ceramic Foam for 1600 F

A ceramic foam which can be used continuously at temperatures up to 1600 F has a density of about 20 lb per cu ft. The foam is supplied to the user with a consistency resembling damp sand. It is packed or tamped into the cavity to be filled. Complete filling of even complex volumes and/or the embedment of electronic items in foam is said to be among possible applications. Other uses include thermal insulation and as the core material in sandwich structures, including radomes.

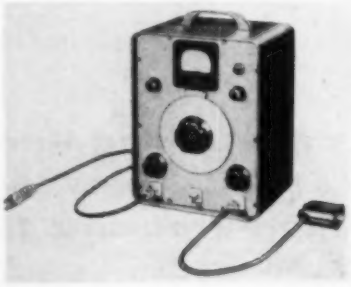
At both room temperature and 1600 F, compressive strength is above 400 psi. Dielectric constant is about 1.5 and dissipation factor is below 0.005. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

For more information—
Circle 15, inside back cover

Measures Rate of Pressure Change

Rate of pressure change can be measured directly with this transducer system. With an adaptor and resistor element, the electrical current (rate of change of charge) generated in the Swiss-made quartz crystal transducer is measured by an electrostatic-type amplifier and displayed on a standard oscilloscope or recorder.

Response is said to be 15 microsec. Designed for indicating combustion and detonation phenomena in the evaluation of new engines and fuels, other applications include shock tubes, gun tubes, rocket motors and hydraulic or pneumatic systems.



The stainless steel pickup is rugged enough to withstand diesel combustion and other temperatures up to 600 F, without special air or water cooling. The amplifier-calibrator unit contains circuitry for calibration of the pickup, adjustment of the oscilloscope and for signal evaluation.

The indicator is said to perform as well in the range of 0 to 1 psi, as in the range of 0 to 1000 psi. Kistler Instrument Corp., 15 Webster St., N. Tonawanda, N. Y.

For more information—
Circle 16, inside back cover

ELECTRICAL POWER, CONTROL

Multiple-Station Switch

This switch can be supplied in any multiple of stations from 1 to 37. A choice of functions are possible, including: 1) interlock–actuating of a button automatically restores to normal the button previously actuated; 2) non-locking–each button has momentary action; 3) all lock–accumulative locking of each button–all restored to normal by actuating release button; 4) interlock and non-lock combination–choice of function so that certain stations will interlock and others non-lock (without affecting the interlocked stations); 5) all lock and non-lock combination–choice of function so that certain stations have accumulative locking features and others will not lock (release button restores locked stations).

Center-to-center distance between buttons is $\frac{3}{8}$ in. Plungers are designed to accept standard push-on buttons. Depth required behind panel is 3 17/64 in. Length depends on number of stations. Height is variable depending on the circuit. Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill.

For more information—
Circle 17, inside back cover

Rectangular Panel Instruments

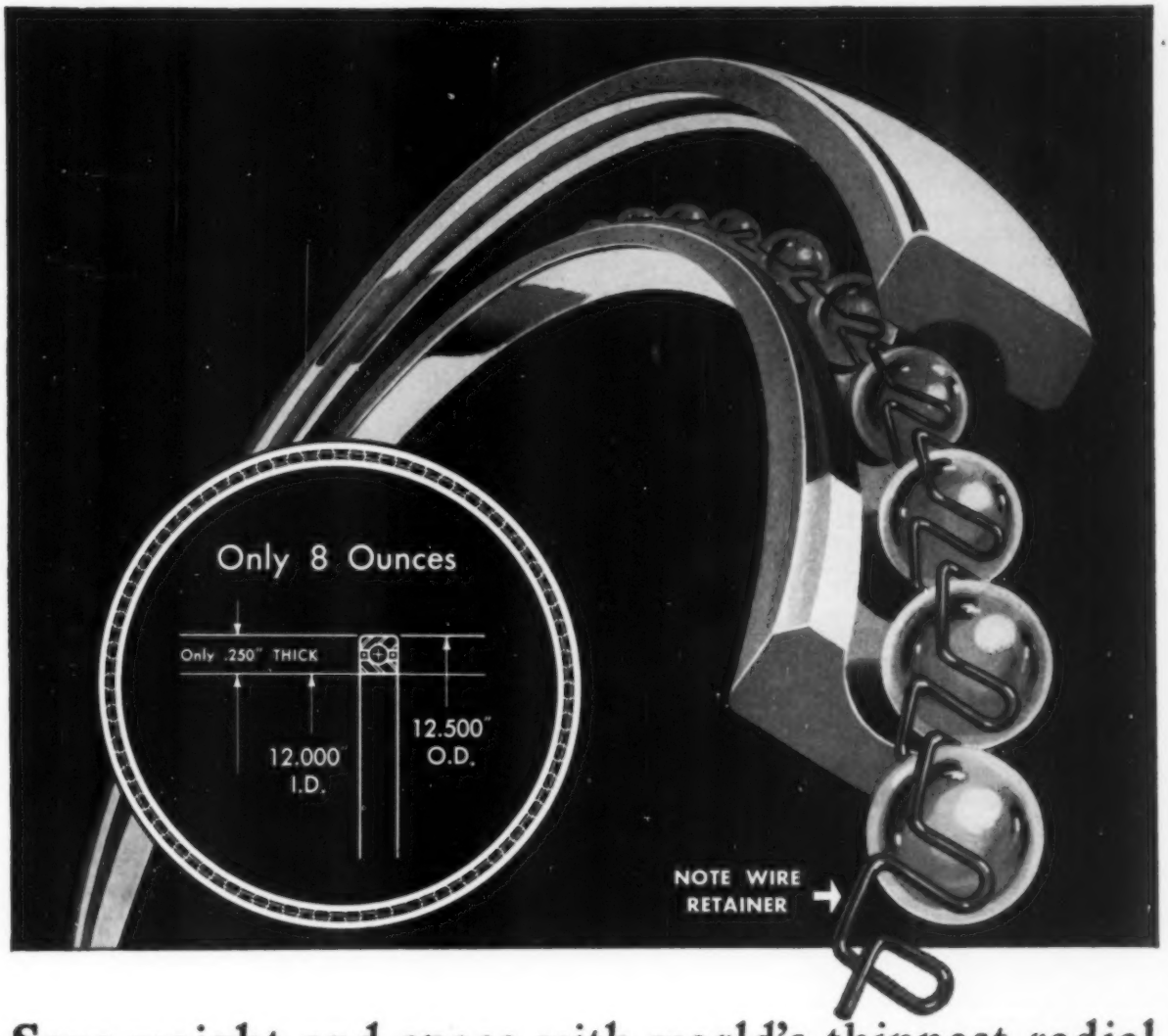
These panel instruments are built in $2\frac{1}{2}$, $3\frac{1}{2}$ and $4\frac{1}{2}$ in. models with any practical range, a-c and d-c. The plastic cover is formed in one piece and can be supplied in black or colors. Two movements are available–the manufacturer's standard magnet type, or the self-shielded core magnet meter movement. Special scales can be supplied also. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

For more information—
Circle 18, inside back cover

Differential Pressure Switch

This pressure switch will make or break electrical circuits when the difference between two pressures is equal to or greater than a predetermined value. Low and high operating pressures are 250 and 500 psi. Weight is 0.75 lb.

CONTINUED ON PAGE 224



Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

K-561

All types of ball and roller bearings — 4" to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Needle Roller • Ball Radial • Ball Thrust Bearings.

The pressure differential is sensed by a diaphragm-type capsule designed to withstand excess pressure without sacrificing sensitivity. Gulton Industries, Inc., Metuchen, N. J.

For more information—
Circle 19, inside back cover

Subminiature Hermetically Sealed Relay

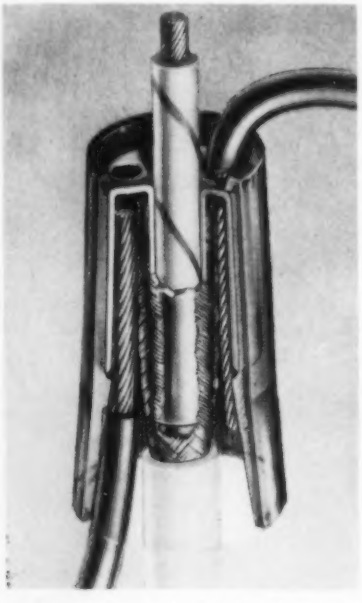
Weighing less than ¾ oz and no larger than a 3¢ stamp, the relay's standard specifications include: contacts—double-pole, double-throw, bifurcated break-before-make, or make-before-break contacts. Contact rating is 3 amp resistive at 115 v a-c or 28 v d-c. Coil resistance up to 10,000 ohm is available. Temperature limit of standard units is to 125 C. Ace Relay Associates, Inc., 103 Dover St., Somerville, Mass.

For more information—
Circle 20, inside back cover

One-Piece, Insulated Connector

A connector for shielded or coaxial cable is composed of a one-piece combined inner and outer ring and Nylon insulation. The inner ring slides under the shielded braid as the tap wire is held between the braid and the outer ring.

Single or multiple taps, from either the front or the back of the connector, can be accommodated. A single crimp with a special tool completes the assembly. The insulation is color-coded for size identification and extends beyond both ends. Burndy Corp., Norwalk, Conn.

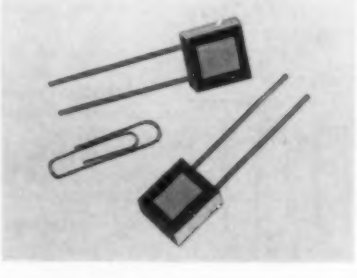


For more information—
Circle 21, inside back cover

Controlling Photocell

Primary use is expected to be direct operation of a-c or d-c relays and electronic trigger circuits at 1000 counts per sec. Continuous power dissipation of ¼ w, with short interval higher peaks, is said to be practical. Voltage rating is 120 v a-c or d-c. Total encapsulation in resin makes it moisture-proof and shockproof. Photosensitivity is substantially independent of temperature from 0 to 175 F and decreases slightly as it approaches 212 F.

The cell operates as a non-polar variable resistor, and the lowest sensitivity unit will pass 10 ma at 22.5 v at 50 ft-c. Dark resistance is over 1 megohm. Maximum sensitivity is to bluegreen light at 5100 angstroms, although cadmium sulfide as used here gives a useful response to violet and red-orange light. Dimensions: ⅜ x ⅜ x ¼ in. thick. Hupp Electronics Co., 743 Circle Ave., Forest Park, Ill.



For more information—
Circle 22, inside back cover

Elapsed Time Recorder

This device records loaded time only of motor-driven machines or electrical apparatus. The meter is 4 x 2⅝ in. deep. Designed especially for motors or electrical apparatus which run constantly and are engaged by clutch to a load. This meter can be supplied in digits 999.9 to 99999.9, in hours or minutes, and for 115 v and up to 25 amp. Adaptable to higher voltages by means of a resistor or transformer. Capeway Instrument Corp., N. Bedford St., E. Bridgewater, Mass.

For more information—
Circle 23, inside back cover

High-Temperature Limit Control

This thermal control cuts off heat supply if a predetermined temperature, set on the calibrated scale, is exceeded. Bulb temperature is indicated on the calibrated scale at all times. Snap-acting switch in the control circuit is the manual reset type. Once the temperature has risen to the predetermined set point, and the switch has broken the control circuit,

CONTINUED ON PAGE 226

Using

DU PONT ELASTOMERS

NEOPRENE · HYPALON®

in Design

Coatings of HYPALON® add beauty and durability to a variety of products

DuPont's new synthetic rubber, HYPALON, can now be applied as a protective coating on rubber, metal, wood or fabrics. It can be applied by spraying, brushing or spread coating. The development of these coatings, both clear and colored, has opened new avenues of product design in a wide range of applications. Here are the advantages such coatings offer:

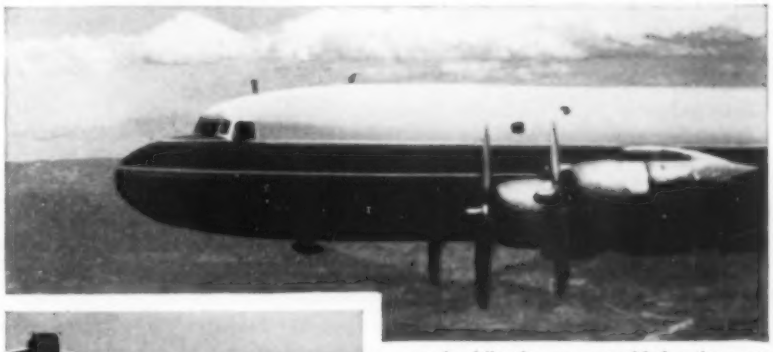
HYPALON is unaffected by ozone. It has unusual resistance to hardening at elevated temperatures (250°-350°F.). It is unique in its resistance to weathering and oxidizing chemicals. And, in addition to the protective benefits of HYPALON coatings, an unlimited range of stable colors is available to add beautiful and functional color to your products.

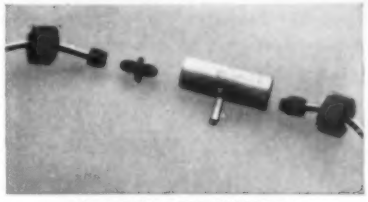
Applications for HYPALON coatings include tank linings, footwear, tarpaulins, camera bellows, hose, belts and automotive and sporting equipment. For other uses see the photograph below.

How can coatings of HYPALON fit into your design problems? Mail the coupon for more detailed information about your specific problem.

These products feature attractive protective coatings of HYPALON: a piece of corrugated rubber mat (left foreground); a coil of electrical wire, and a child's overshoe on the mat; rubber extrusions for automobile windshield frame and trunk weatherstripping (center foreground); door weatherstripping (right foreground); slab of urethane foam (left rear); basketball (right rear).

NEOPRENE SEALS safeguard fuel line connections in the Douglas DC-7





SEAL READY FOR ASSEMBLY

Safety of passengers is uppermost in the minds of Douglas Aircraft designers—even down to as small an item as the rubber sleeve on a fuel line connector. Douglas uses the best metal connectors to join its fuel lines, but as an additional safety factor the company fits a vapor-tight sleeve seal over each joint which is vented by tubing to the ship's exterior to prevent any possible accumulation of highly flammable gasoline vapors within the fuselage.

Before switching to neoprene, Douglas had a problem with the seals. They required frequent replacement because ozone caused the rubber to crack. In fact, many of the rubber seals were rejected as unusable before installation because of ozone cracks which developed while the pre-assembled units were held in stock.

The installation of neoprene seals proved to be the answer to the problem. Neoprene was chosen because it resists ozone, gasoline, oil and aging. Many of the neoprene seals have been in service for over two years, reducing maintenance and replacement costs.

Perhaps your design problems can be solved by the use of Du Pont neoprene. We'd be glad to send you further information—property data and proven applications. If you have a specific problem, please let us know in the coupon.

NEOPRENE SEALS (in red) resist ozone, oil, gasoline and aging. Many of them have lasted for over 2 years.

DU PONT

REG. U.S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

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E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. PG-4
Wilmington 98, Delaware

Firm _____

Address _____

City _____ State _____

the circuit cannot be re-established until the manual reset button has been pressed. A second switch has been provided in series with the control switch. This second switch normally is closed. It will open only if the temperature should drop to a point below the lowest expected ambient temperature. This provides a fail-safe arrangement. Scale and element ranges available are 0 to 900 F and 0 to 1100 F. Partlow Corp., New Hartford, N. Y.

For more information—
Circle 24, inside back cover

Flat, Multiple-Conductor Cable

Completely flexible, the conductors can be ripped apart and easily separated. The wires, No. 26 and larger, are color-coded for easy identification. Cable can be made up to include shielded wires with outer jackets and can be supplied in multiple layers. The conductors have temperature ratings up to 100 C. William Brand & Co., Inc., Willimantic, Conn.

For more information—
Circle 25, inside back cover

Five-Way Binding Post

Available in two models for plug-in connection of either a 0.080 in. test probe or a standard ¾ in. banana plug, the post has a spring pin contact. The following types of connection are provided for: wire lead looped around shaft and clamped; wire lead inserted through hole in shaft and clamped; alligator or clip lead fastened to shaft;

spade lug inserted around shaft and clamped; either banana plug or probe plugged into jack in knurled thumb screw. Raytheon Mfg. Co., Waltham 54, Mass.

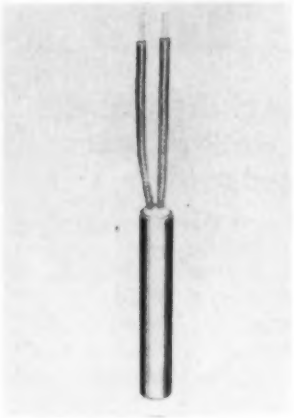
For more information—
Circle 26, inside back cover

Adjustable Input Controller

The controller accurately controls temperatures by interrupting the heating circuit at regular intervals, adjustable on a dial calibrated from 0 to 100 per cent of basic cycle. The dial is set at 50%, power is fed to the heating elements for 30 sec, constantly repeating.

Controllers are equipped with synchronous motors, rated for operation from 115 or 230 v 25, 50 or 60 cps. Automatic Temperature Control Co., 5200 Pulaski Ave., Philadelphia 44, Pa.

For more information—
Circle 27, inside back cover



High-Temperature Heating Element

One of these heaters, measuring ½ x2¼ in. length and rated at 115 v, 250 w, (which would give it a watts density of 90w per sq in.), has been operated in open air for periods up to 720 hr, continuous, at a sheath temperature of 1800 F. Watlow Electric Mfg. Co., 1376 Ferguson, St. Louis 14, Mo.

For more information—
Circle 28, inside back cover

Engine Cranking Switches

Magnetic cranking switches, featuring 6, 12, 24 and 32-v models, are expected to be applicable to engines on trucks, buses, off-highway units, and industrial and marine installations. The switches are totally enclosed, and

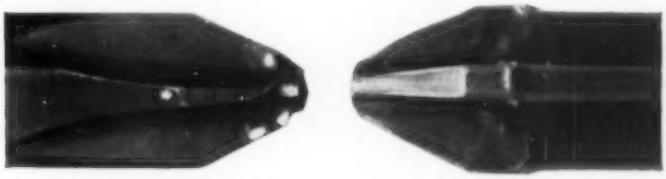
CONTINUED ON PAGE 228

Count on CONTINENTAL

for the HY-PRO PHILLIPS BITS that

outlast other bits 2 to 1

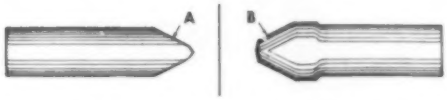
Repeated tests made under assembly line conditions prove that Continental's HY-PRO Phillips Bits have an average service life *double* that of the best comparable bits. Reports from users, of their own experience on the job, show even greater margins of extra life for HY-PRO Bits, often as high as 4 to 1.



Best Comparable Bit — HY-PRO Phillips Bit

Each Bit Drove Same Number of Screws

HY-PRO Bits are FORGED for longer life



As shown in the diagrams above, the strong outer fibers of the bit blank, which are removed in milled bits (A), are retained in the Hy-Pro forged bit, and concentrated at the point (B) where highest strength is required.

Make your own tests—Continental Assembly Specialists will cooperate fully in setting up tests. Compare bit life on your toughest driving jobs. Figure all costs . . . you'll find Continental's HY-PRO Insert Bits and Holders your best buy for production efficiency, for assembly economy.

Only CONTINENTAL makes both PHILLIPS BITS and SCREWS

HY-PRO Bits will give you a big margin of extra service life in assembly with any Phillips Screws. But, for maximum production efficiency, use the proved combination — HY-PRO Bits *and* HOLTITE Phillips Screws.

Precision control with the same Phillips master tools assures uniformly accurate fit of HY-PRO Phillips Bits and HOLTITE Phillips Screw recesses. It gives you the dependable fit you need in all production assembly, especially with power and automatic driving equipment, to avoid downtime, rejects, and weak fastenings. For full information, write: Continental Screw Company, 452 Mt. Pleasant St., New Bedford, Mass.

HY-PRO

POWER BIT HOLDERS
are made in types and sizes to fit all driving tools

MEMBER OF THE SCREW RESEARCH ASSOCIATION

CONTINENTAL
HOLTITE FASTENERS

HOLTITE PHILLIPS AND SLOTTED HEAD
WOOD • MACHINE • TAPPING • THREAD CUTTING • SEMS • NYLOK
HY-PRO PHILLIPS INSERT BITS AND HOLDERS

of waterproof construction. Leece-Neville Co., 1374 E. 51 St., Cleveland 3, Ohio.

For more information—
Circle 29, inside back cover

Pressure Transmitter

An indicating pressure transmitter, accurate to $\pm\frac{1}{2}$ per cent of scale, provides pneumatic transmission of process pressure measurements. It measures pressures of 0 to 30 in. of water to 0 to 6,000 psi, transmitting a 3 to 15 psi air signal to indicating, recording or controling instruments.

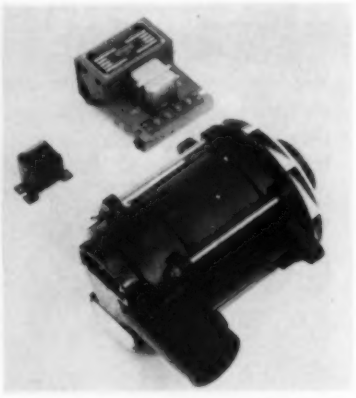
To accommodate the various ranges, a choice of pressure elements is offered: spirals, helicals, bellows and diaphragms; element materials are available for corrosive process fluids.

Transmitter is $8\frac{1}{8}$ x $5\frac{7}{8}$ x $4\frac{1}{8}$ in. deep; weighs 8 lb. Foxboro Co., Foxboro, Mass.

For more information—
Circle 30, inside back cover

A-c Power Supply for Mobile Installations

Consisting of an alternator, a regulator and rectifier, the power supply may be used with lighting systems on applications such as crop harvesting equipment, power boats, construction



vehicles, power shovels, railway maintenance-of-way equipment as well as heating systems on bakery trucks. Operating independently of any other source of electrical power, the package may be applied wherever an accessible rotating shaft exists.

Specifically intended to be belt-coupled to a rotating shaft, the alternator has an automotive-type three-point mounting for easier installation and adjustment of belt tension. The unit can withstand rotational speeds up to 10,500 rpm. It does not require interconnection with existing electrical systems.

Pre-set at the factory, the regulator is a finger-type unit and capable of holding output voltage variation to ± 3 per cent from no-load to full load, and from minimum to maximum alternator speeds. General Electric Co., Schenectady 5, N. Y.

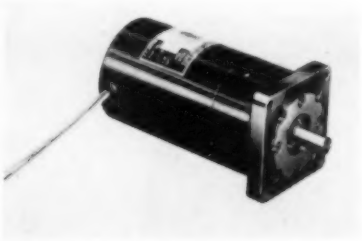
For more information—
Circle 31, inside back cover

Miniature A-c Motors

A line of standard motors, for 115 or 200 v, a-c, 60 or 400 cps, has frame size of 1.675 x 4.5 in. long. The motors are wound for single-phase (with a capacitor) or two-phase operation, two, four, or six-pole, and three-phase, two and four-pole.

Motors can be furnished with integral planetary gear reducers, offering 102 ratios between 4:1 and 3 million:1. By varying the speed of the basic motor, up to 306 standard output speeds are available.

These gear-reduced motors are supplied with induction or hysteresis rotors: the former produces up to 3.5 in-oz torque, the latter, operating at synchronous speed, produces up to 1.2 in-oz torque. Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.



For more information—
Circle 32, inside back cover

Vinyl-Insulated Wire

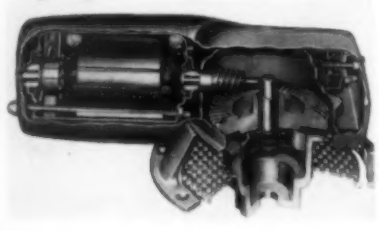
This wire is available in gages of No. 26 to 20 with 0.009 in. wall. It has a 300-v UL-rating for use in electrical accounting and bookkeeping machines and electronic computers. William Brand & Co., Inc., Willimantic, Conn.

For more information—
Circle 33, inside back cover

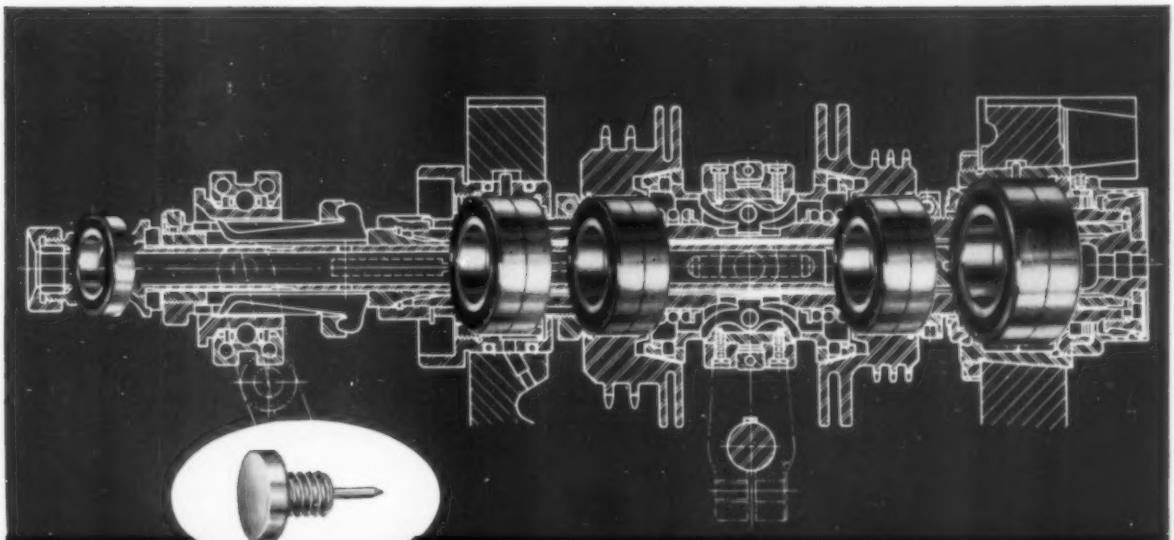
Pushbutton Starter for Engines Up to 8 Cu. In.

Available for either battery or 110-v, a-c operation, this starter is for small gasoline engines such as those used on lawnmowers, generators and other such equipment. Battery-operated unit is made up of starter assembly motor, 12-v battery with a built-in recharging system (uses standard 110-v, 60 cps, a-c), charger cord and pushbutton switch. The dry-type battery is said to provide enough power for 150 or more normal starts without recharging.

Dimensions for 110-v a-c operation



CONTINUED ON PAGE 230



7 seconds from nothing flat!

The brass part illustrated below the diagram is produced on the new 00 Brown & Sharpe Automatic Screw Machine in 7 seconds. That represents a 42% increase in production over the previous model.

To step up production by such a substantial percentage involved the development of new and exclusive features for the 00 machine over and above those proven so successful on the previous model. Included among them is the chain-driven, ball bearing spindle . . . see large diagram above.

In the selection and application of the bearings for the 00 spindle, Fafnir engineers worked with Brown & Sharpe engineers. The 208 speed combinations from a high of 7200 RPM to a low of 34 RPM, permitting high cutting efficiency on a wide range of materials, presented no ordinary problem for bearings. The bearing arrangement shown meets an exacting demand for maximum radial and axial rigidity to assure true balance and running accuracy of the spindle.

Could be there's no place in your machines for these super-precision bearings. But, whenever bearings are involved, there's certainly a place in your product planning for the Fafnir "attitude and aptitude" — a way of looking at bearing problems from the designer's viewpoint plus coming up with the right bearing to fit the need. Ask your Fafnir representative for details. The Fafnir Bearing Company, New Britain, Conn.

The New Brown & Sharpe No. 00 Automatic Screw Machine with Fafnir-equipped spindle.

Fafnir preloaded, angular-contact, super-precision ball bearings with composition or brass retainers are made to highest industry-approved tolerances. Single or duplex bearings like this are used widely on spindle applications.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

are 9 1/8 x 4 7/16 x 3 5/16 in. Weight of this unit is 6.6 lb, battery-operated unit about 21.75 lb. Fairbanks Morse & Co., Magneto Div., Beloit, Wis.

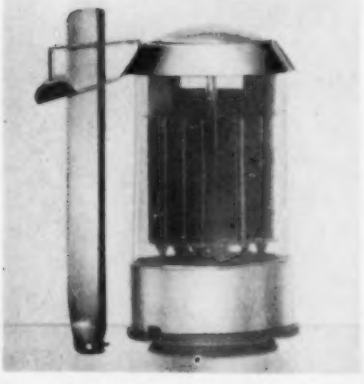
For more information—
Circle 34, inside back cover

Subminiature Pressure Switch

Mounted through the wall of a pressurized vessel, the bellows compression completes a signal circuit when the pressure charge in the vessel is at a set value. The pressure switch itself is grounded and the circuit is completed through the pigtail. This sub-miniature unit will make and break a 6 to 8 v resistive d-c circuit, carrying up to 250 milliamp.

Available in ranges of 50 to 500 psi, the unit can sustain burst pressures to 1000 psi. Aircraft Controls Co. Div., Gorn Electric Co., Inc., Stamford, Conn.

For more information—
Circle 35, inside back cover



Top-Holding Tube Retainers

Consisting of two stainless steel parts, a post and a cap, these holders are available in single and double post modifications to hold all tubes and cylindrical components ranging from 5/8 to 2 7/8 in. dia. Post heights range from 5/8 to 5 1/2 in., in increments of 1/8 in.

The holder can be removed for tube maintenance with a slight upward pressure on the locking tab. The cap rides on a double rail which is serrated on the bearing edge. Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

For more information—
Circle 36, inside back cover

Coaxial Cable

The cable has a nominal capacitance of 10 mmf per ft at 1000 cps, with an 0.220 in. OD. The conductor is No. 30 AWG, 7/38 silver-plated copper.

Outer jackets of Teflon, lacquered nylon braid or silicone-impregnated glass braid are available as standard constructions. Tensolite Insulated Wire Co., Inc., 198 Main St., Tarrytown, N. Y.

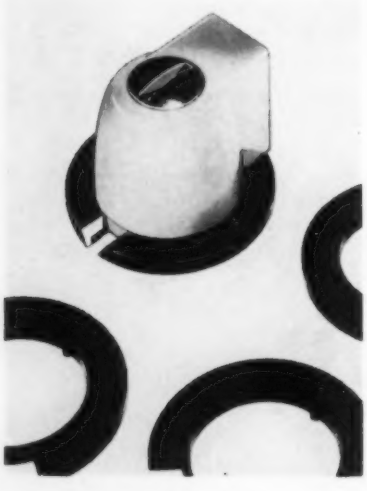
For more information—
Circle 37, inside back cover

Collet-Fitting Military Style Knob

The positive locking collet is said to eliminate possibility of inoperativeness due to loosening on the shaft. The collet snugly grips the shaft, evenly distributing locking pressure on all outside surfaces of the shaft. It absolutely will not scratch or gouge the shaft surface. The collet is actuated by a slotted cap screw, made to fit screwdrivers, and in emergencies, a coin.

The knob has a 7/8 in. dia and height, fitting on military style 1/4 in. flatted shafts. The knob material is thermoplastic. Dale Products, Inc., Columbus, Neb.

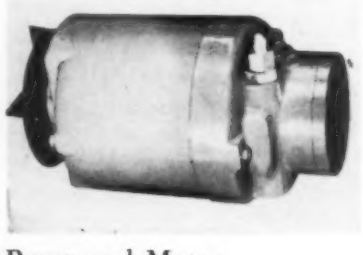
For more information—
Circle 38, inside back cover



Aircraft Induction Motor

This motor weighs 4.8 lb and is rated 6 1/2 hp, 24,000 rpm, three-phase, 208 v, 400 cps. Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

For more information—
Circle 39, inside back cover



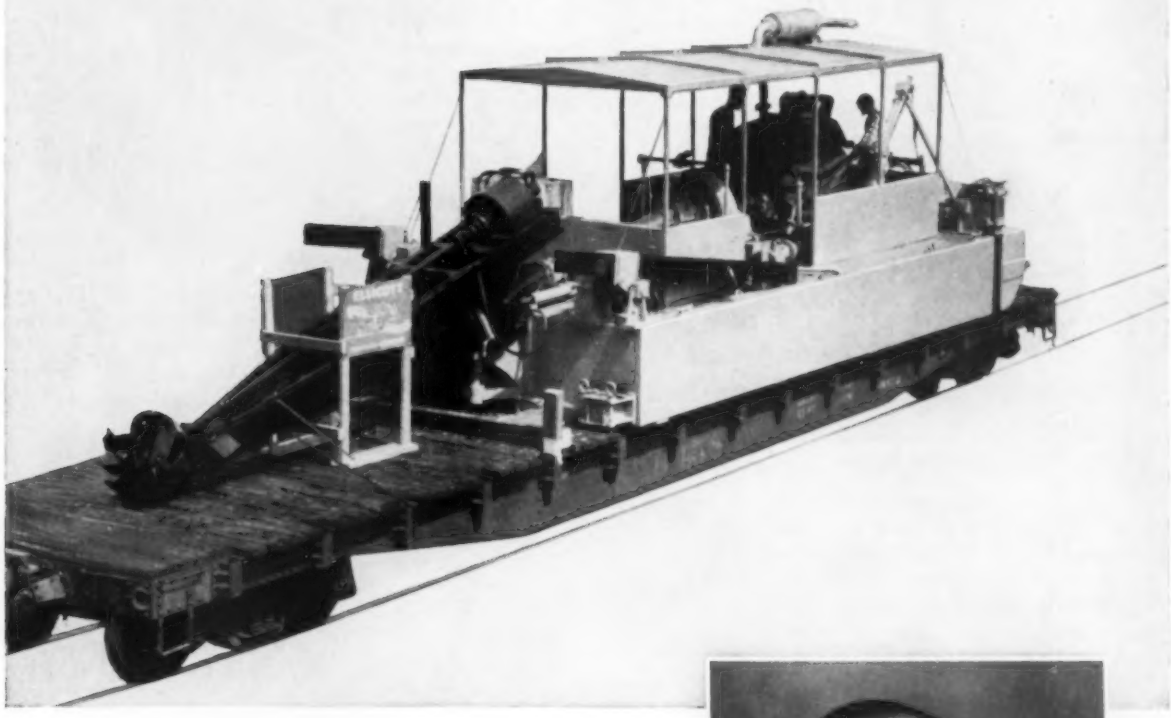
Pump and Motor

A positive displacement, internal gear rotary pump, a driving motor and a cooling blower is combined in a space measuring 8 1/2 x 4 3/4 in. dia. A single shaft serves all units. These combinations have been successfully used in hydraulic, lubricating, oil burning and other services involving different fluids.

Capacity of this model is 18 gph at 300 psi. It is driven by a 1/12 hp motor

CONTINUED ON PAGE 232

An Ellicott "Dragon" Dredge, constructed in part with Standard Steel Works forgings, ready for rail and freighter shipment to Hong Kong.



"To maintain our position of world leadership we must have superior service from our suppliers"

As suppliers of countless forgings to the Ellicott Machine Corporation for 30 years, we at Standard Steel Works feel we have been an integral part of the growth of Ellicott and in helping this world's largest dredge manufacturing company maintain its top position through all those years. We appreciate the fact that Mr. Mund and his associates realize it is not only by meeting design and steel analysis requirements for Ellicott, but also by consistently combining our know-how in steel fabrication with personalized attention to each order, that we have maintained our mutually satisfactory relationship. Every order we receive we accept as a service opportunity.

It is routine at Standard Steel Works to analyze all orders carefully and to present its requirements and possible problems on a personal, conference basis to the appropriate men in the shop; then to keep the customer continually advised on the progress of his order through our shops by means of frequent, periodic job-status reports. Our customers, whether they manufacture equipment for local use or for shipment to the far corners of the world, know that they can count on Standard Steel Works to deliver the right forgings at the right time—to help them maintain delivery schedules. Write or call Dept. 4D today and give us the opportunity to show you how our personalized service can prove invaluable in your operations.

"We are justly proud of our position as the world's largest designers and manufacturers of hydraulic dredges. Standard Steel Works is one of our suppliers which—in giving us that extra plus, superior service, while meeting our requirements for various forgings—have helped us maintain our world-wide leadership," *says Allan Mund, Vice President and General Manager, Ellicott Machine Corp., Baltimore, Md.*

Standard Steel Works Division

BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

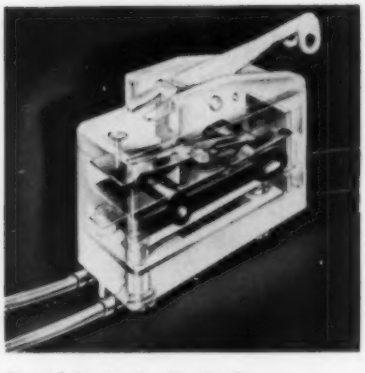
at a speed of 1750 rpm. Dept. PR, Tuthill Pump Co., 939 E. 95 St., Chicago 19, Ill.

For more information—
Circle 40, inside back cover

Two-Phase 60-cps Servo

A size 15, 115-v servo weighs 7.6 oz. It delivers 1.45 in-oz min stall torque. Phase one is 115 v and phase two 115 to 57.5 v. Speed is 3200 rpm at no-load. At stall, current is 0.060 amp per phase and power 6.1 w per phase. John Oster Mfg. Co., Racine, Wis.

For more information—
Circle 41, inside back cover



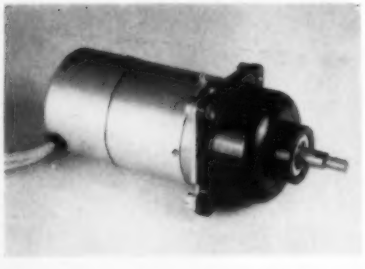
Double-Pole Switch

The switch is a lever-actuated, double-pole, single-throw, normally closed switch. Overall size is $1\frac{7}{8}$ x $1\frac{1}{2}$ x $\frac{3}{4}$ in.

Parts necessary to the mechanical operation of the switch, including the spring, do not carry electric current. The mechanical (or upper) part of the switch is separated from the electrical (or lower) part by a division inside the switch case which is made of non-conducting, non-absorbent plastic material.

Because mechanical and electrical parts are completely separate, the problems resulting from loss of tension and failure in the spring due to overheating and metal fatigue have been eliminated, according to the manufacturer. The electrical conductor is made of beryllium copper; contact points are heavy silver and are self-cleaning. Steel parts are cadmium-plated to resist moisture. Dimensions: $1\frac{7}{8}$x$1\frac{1}{2}$x$\frac{3}{4}$ in. Taitco Div. Tait Mfg. Co., Dayton 1, Ohio.

For more information—
Circle 42, inside back cover



Miniature Gear Head Motor

Specifications are 115 v d-c, ±5 v d-c. Output speed is 12.5 rpm, ±25%. Current drain is 100 ma.

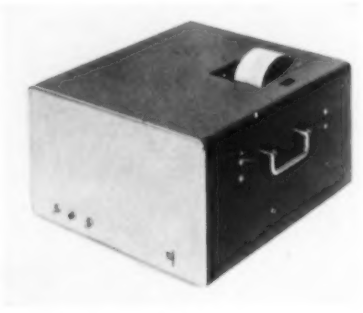
This d-c motor is designed for intermittent duty and is reversible. Western Gear Corp., Electro Products Div., 132 W. Colorado St., Pasadena 1, Calif.

For more information—
Circle 43, inside back cover

Printer for Electronic Counters

The digital printer has been designed to operate from four-line, 1-2-2-4 binary code, thus it may be used with most existing counting equipment without modification. It is suitable for interval meters, totalizing counters, preset controllers and time-function translators.

Print-out capacity is six digits (up to 12 digits optional). Accuracy: identical to characteristics of counting instrument counting period; identical to characteristics of counting instrument; Display time: 0.2 sec min, maximum controlled by counting instrument; Dimensions: 14 x 8 x 10 in. deep. Computer-Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif.



For more information—
Circle 44, inside back cover

Subminiature Photo-electric Detector

This detector is the size of a sewing thimble. The unit is self-generating. The device furnishes output proportional to input light intensity and loading. Typical input-output proportions are 300 milliv at 100 ft-c into 1 megohm, or 20 microamp at 100 ft-c into 100 ohm. Autron Engineering, Inc., 1254 W. 6 St., Los Angeles 17, Calif.

For more information—
Circle 45, inside back cover

Torque Motors

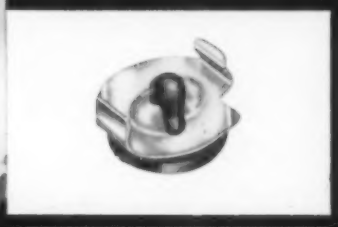
Three torque motors, designed for aircraft and missile servo systems operate with very high natural frequencies and low phase lag. They operate dependably under adverse temperature

—CONTINUED ON PAGE 234

DOT

THREAD CUTTING FASTENER
HOLDS TIGHT TO CURVED SURFACES

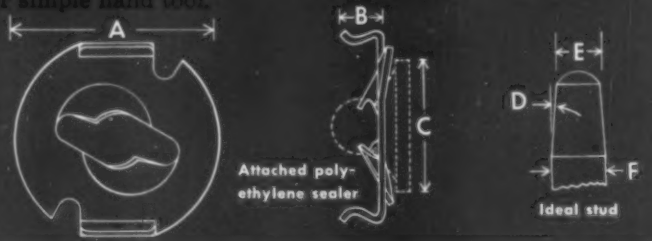
- Low Cost
- Re-Usable
- Self-Locking
- Vibration-Proof
- Spring Take-Up

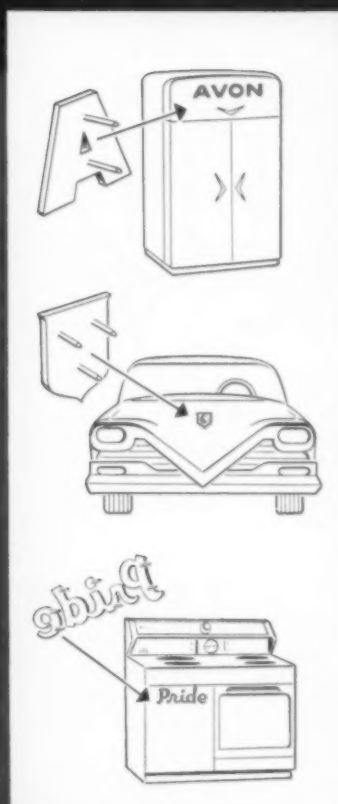


Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces . . . DOT'S unique T.C.F. can be used in many other applications which require a spring take-up fastener that pulls up tight without backup on flat or contoured surfaces.

It cuts clean, deep threads on unthreaded studs, even those that are chrome plated. When used with its preassembled plastic sealer, T.C.F. makes a water-tight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity*, with or without sealer, to fit 1/8" and 3/16" studs. Drawings available on request for magnetic tool or simple hand tool.





Nominal Sizes	A	B	C	D	E	F	Driving Torque	Ultimate Strength
1/8"	.560	.170	.450	6°/4°	.095 .085	.130 .125	7-10 Inch lbs.	200 lbs.
3/16"	.705	.200	.450	6°/3°	.160 .150	.192 .184	20 - 30 Inch lbs.	400 lbs.

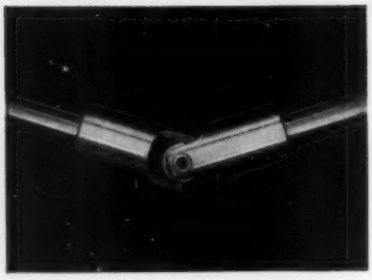
Manufactured by
MONADNOCK MILLS SUBSIDIARY
San Leandro, Cal.

DOT T.C.F.
Patent Pending

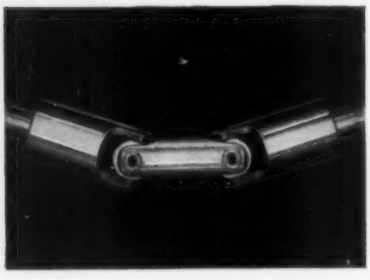
Manufactured by
CARR FASTENER CO. DIVISION
Cambridge, Mass.

UNITED-CARR FASTENER CORPORATION

How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

CURTIS UNIVERSAL JOINTS

because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK —
3/8" to 4" O.D. (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

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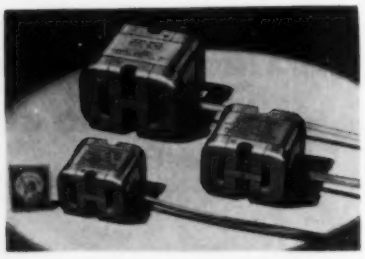
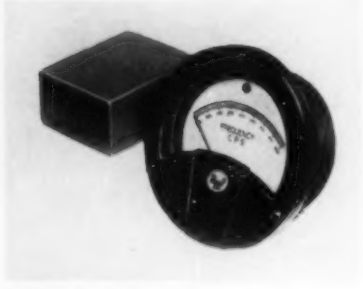
UNIVERSAL JOINT CO., INC.
11 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919



and vibration conditions without zero shift because they are brazed and welded together. These motors are available in three sizes: Model 28 produces a force of 13½ lb, with a ±0.015 in. stroke; Model 24, has an output of 8 lb, and a ±0.008 in. stroke; Model 23 produces 5 lb of force with a ±0.007 in. stroke. Models are also available for industrial applications. Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

For more information—
Circle 46, inside back cover



Silicon Diodes and Rectifiers

Diodes and medium power rectifiers cover the current range from 100 milliamp to 3 amp. All units are stud mounted and hermetically sealed. U. S. Dynamics Corp., 1250 Columbus Ave., Boston, Mass.

For more information—
Circle 47, inside back cover

Liquidtight Electrical Conduit

This electrical conduit is UL-approved. It consists of a flexible galvanized steel tube with a copper bonding strip wound spirally in the spaces between the convolutions, covered with an extruded vinyl plastic sheath. The conduit is also available without the bonding strip, meet-

(Continued on page 238)

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
DeLaval Steam Turbine Co., Trenton, N. J.
Empire Pattern & Foundry Co., Tulsa, Okla.
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Mattison Machine Works, Rockford, Ill.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Michigan
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

SEND FOR FREE BULLETIN 41 TODAY

Meehanite Metal as a Material for Forming & Stamping dies

Write today to Meehanite Metal Corporation, Department 7G, 714 North Avenue, New Rochelle, New York.

MEEHANITE®

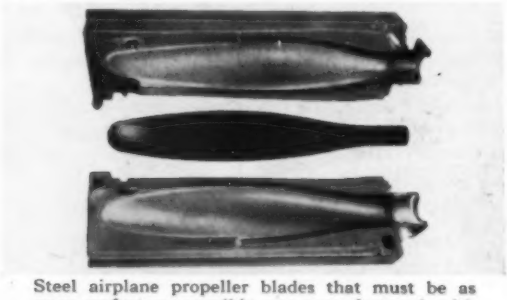
Increase die life and lower production costs with cast-to-form Meehanite metal dies

Longer service life is obtained with Meehanite dies because of their better wear resistance and freedom from galling, scuffing and scoring. Meehanite metal, combining the most desirable properties of gray iron and steel, is one of the most versatile die materials available.

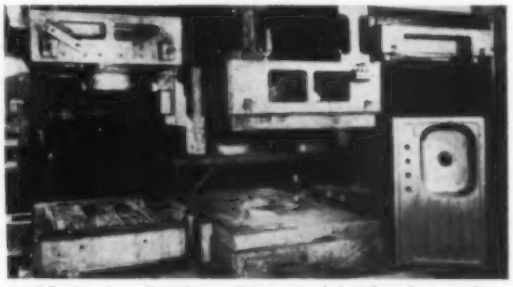
Meehanite dies provide high strength and toughness combined with excellent self-lubricating properties. Dies made in Meehanite metal take on a permanent glass-smooth finish and assure long runs of flawless pressings and shapes. Meehanite dies are used successfully for deep drawing and shaping all steels and non-ferrous alloys.

Substantially lower production costs are achieved by casting large and complicated die parts in one piece rather than building up die assemblies. Machining allowances are held to a minimum and dies may be hardened by local or uniform heat treating without distortion.

For additional information, send for Bulletin No. 41 "Meehanite Metal as a Material for Forming & Stamping Dies."



Steel airplane propeller blades that must be as near perfect as possible are manufactured with Meehanite dies that prevent distortion during quenching after heat treating. The dies shown contain cored passages through which cooling water flows.



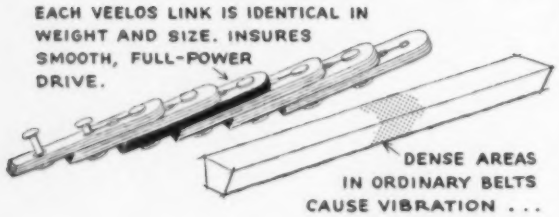
Meehanite dies have been used in drawing and forming operations for over 25 years by the Ingersoll Products Division of Borg-Warner Corporation in the manufacture of stampings for the automotive, farm equipment and home appliance industries.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

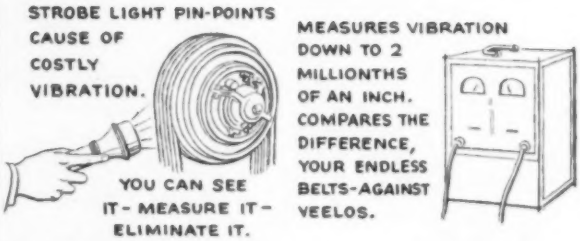
MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

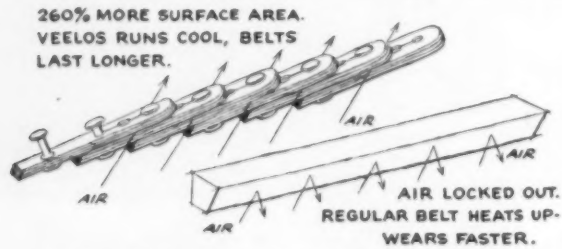
Six Reasons Why Veelos Adjustable V-Belts Are Better For Your Drives!


EACH VEELOS LINK IS IDENTICAL IN WEIGHT AND SIZE. INSURES SMOOTH, FULL-POWER DRIVE.
DENSE AREAS IN ORDINARY BELTS CAUSE VIBRATION . . . MACHINE WEAR

1. Balanced construction of Veelos Belts assures you faster, cleaner work, less rejects . . . less bearing wear. Each link and stud is identical in size and weight. Ordinary belts have varying spots of density which cause excess vibration—chatter marks, machine wear.


STROBE LIGHT PIN-POINTS CAUSE OF COSTLY VIBRATION.
YOU CAN SEE IT - MEASURE IT - ELIMINATE IT.
MEASURES VIBRATION DOWN TO 2 MILLIONTHS OF AN INCH. COMPARES THE DIFFERENCE, YOUR ENDLESS BELTS-AGAINST VEELOS.

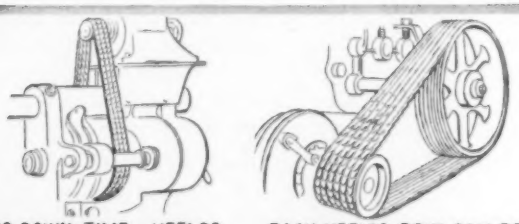
2. Electronic proof—up to 90% less vibration! With a vibration analyzer, you see, on your own machine, how Veelos belts decrease vibration up to 90% over any belt you're now using. This amazing Veelos test pin-points the belt that has the "invisible shakes."



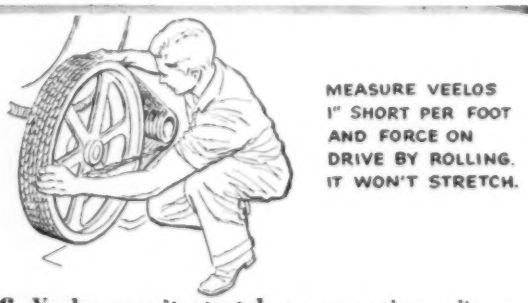
3. Cooler running—long life! Veelos breathes! Constant circulation of air keeps Veelos running smooth. Regular V-belts have no chance to cool, heat builds up from the inside . . . causes slippage, wastes power, heats bearings, reduces belt life.

AREA CONTACT
POINT CONTACT
PERFECT VEELOS FIT. EXTRA THICKNESS AND MACHINE-CUT SIDES PREVENT BOTTOMING. MEAN CONSTANT POWER.
POWERLESS POINT CONTACT OF ORDINARY V-BELT. BULGES, SLIPS, CAUSES UNEVEN SHEAVE WEAR.

4. Greater flexibility reduces slippage! Sectional construction, beveled links allow greater flexibility, longer belt life. Each link moves around sheave independently and maintains full contact, constantly. Full area contact allows shorter centers, smaller sheaves.


NO DOWN-TIME. VEELOS FITS ANY DRIVE - WITHOUT DISMANTLING.
EACH VEELOS BELT CAN BE ADJUSTED - NO NEED FOR EXPENSIVE MATCHED SETS.

5. Simple installation "knocks out" down-time! Saves up to 50% installation time on outboard bearing drives, more when belt length isn't in stock. No resetting, tilting or moving motors. Veelos can be made any length, can be changed by adding or removing links.



6. Veelos won't stretch any more than ordinary endless V-belts when it is properly installed. *Remember—measure Veelos 1" short per foot and roll on drive as tightly as possible.* With the first few revolutions Veelos studs accept a permanent set into the sections they connect.

4 TYPES — FOR ALL DRIVES

REGULAR For general service
OILPROOF For oily and hot drives
COATED For wet or oily drives
STATIC-CONDUCTING For explosive atmosphere

VEELOS
THE BALANCED LINK V-BELT
Known as Veelink outside U.S.A.

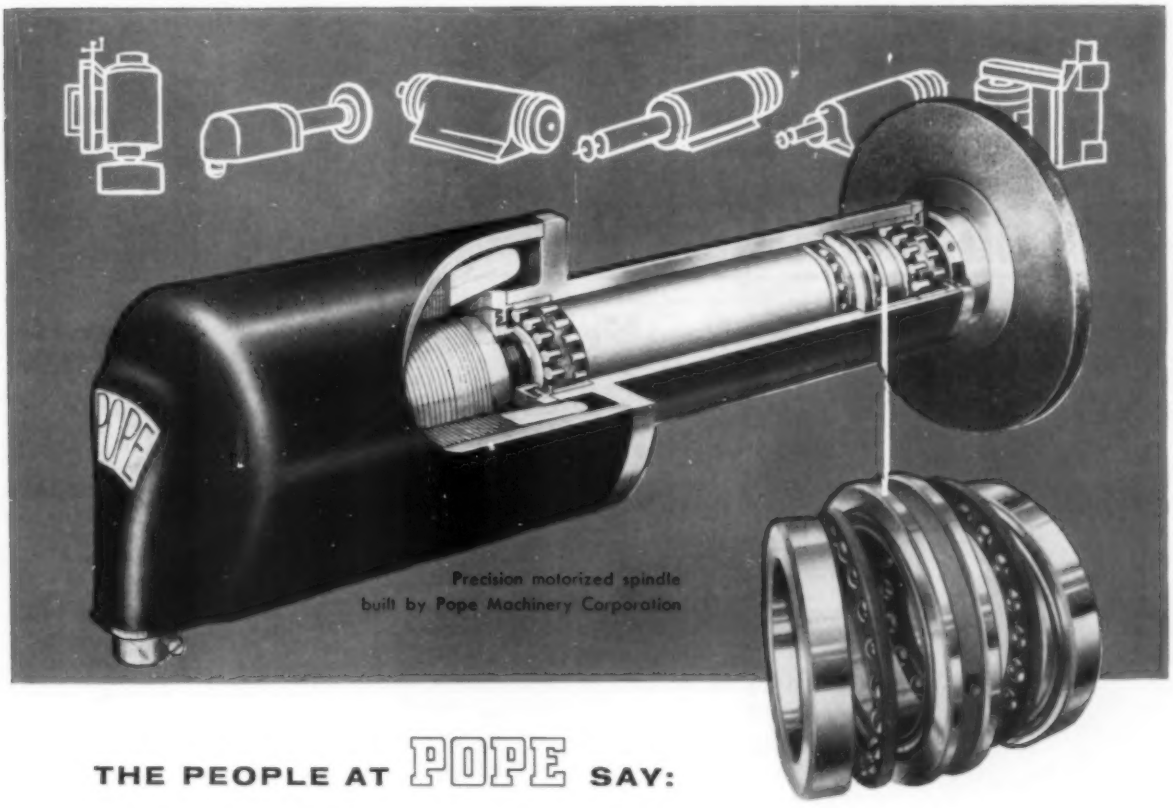
For all sizes and types of drives. Double-V available for serpentine drives.

Write for free Veelos Data Book or Veelos Vibration Demonstration to:

MANHEIM
Manufacturing & Belting Co.
407 Stiegel St., Manheim, Pa.

"Industrial Belt Specialists Since 1911"

© M.M.&B. Co. 1956



Precision motorized spindle
built by Pope Machinery Corporation

THE PEOPLE AT POPE SAY:

DON'T ✣ combine the bearing loads— DIVORCE ↕/↔ them!

Greater rigidity, accuracy, and capacity; lower friction and temperatures under varying loads and speeds; smoother, chatter-free operation that spells finer finishes at lower cost . . . these are the plus advantages offered by Pope precision spindles because they feature the single-direction bearing principle: radial bearings for the radial loads—thrust bearings for the thrust loads.

Aetna spindle thrust bearings, like the special, preloaded, double-acting type used by Pope Machinery Corporation, are built to super-rigid standards of concentricity, parallelism, size, finish and metallurgical structure. They are typical of the many design-engineering successes which have earned Aetna's reputation as a progressive and dependable bearing supplier to the machine tool industry for over forty years.

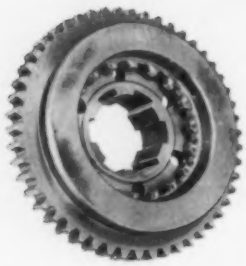
Perhaps you, too, can use Aetna's forward-thinking engineering teamwork to good advantage. It's teamwork you can swing into action simply by writing us or 'phoning the representative listed under the Aetna trade-mark in your classified 'phone book. Why not do it today?

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts

AETNA BALL AND ROLLER BEARING COMPANY
Division of Parkersburg-Aetna Corporation
4600 Schubert Avenue • Chicago 39, Illinois

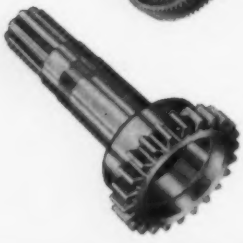
There is only ONE Best Gear Design for each application

. . . and SIER-BATH manufactures it into your gears



Sier-Bath serves you with the best gear design, engineering and manufacturing service. You get free engineering consultation and the finest gears to meet the increased requirements of tomorrow.

Sier-Bath designed and manufactured gears give you the same operating advantages that have brought leadership to many other machinery manufacturers.



No other gear company can now give you
PRECISION CROWN-GROUND SPUR GEARS
to 12″ diameter, 4 pitch

Send us your gear prints or specs for study and quotation—or have a Sier-Bath gear specialist call to discuss the steps that will make us your ideal gear department.

Sier-Bath PRECISION GEARS

All kinds of gears—all materials.
Made—cut—shaved—ground teeth.
48″ maximum diameter
12 or more of a kind, depending on size

Sier-Bath GEAR & PUMP CO., Inc.
9238 HUDSON BOULEVARD NORTH BERGEN, N. J.
Founded 1905 Members A.G.M.A.

Also manufacturers of Rotary Pumps and Flexible Gear Couplings

ing JIC standards.

The conduit is being specified as original equipment on many types of machinery: pumps, compressors, air-conditioning towers, machine tools, printing presses. The conduit is manufactured in sizes ranging from $\frac{3}{8}$ to 2 in. Columbia Cable & Electric Corp., 255 Chestnut St., Brooklyn, N. Y.

For more information—
Circle 48, inside back cover

Frequency Meters

The meters consist of a 3 in. D'Arnsoval galvanometer and a case (approximately 2 x 3 x 1.5 in.) containing potted circuit components. Accuracy is within 0.1% for a 120 v, ±35% source at a constant ambient temperature.

Operating frequencies and scale expansion of standard models are: 50 cps, ±2 cps; 60 cps, ±2 cps; 400 cps ±20; 50 cps, ±2 cps, switchable to 60 cps, ±2 cps. Power consumption of the standard models is 1 w. A corresponding series of temperature-controlled meters have intermittent excursions to 20 w. Alexandria Div., Defense Products Group. American Machine & Foundry, 1025 N. Royal St., Alexandria, Va.

For more information—
Circle 49, inside back cover

Light Lock-Down Switch

The switch functions as a conventional pushbutton type when pushed straight down. When pushed and turned approximately 20° clockwise, the switch pops up to unoperated position.

The switch is said to be capable of taking the place of an alternate-action pushbutton, and also providing optional momentary action. A subminiature bulb, independent of the switch circuit, illuminates the switch's translucent button. Two subminiature basic switches, actuated by positive

(Continued on page 241)

DOW CORNING CORPORATION

Silicone News

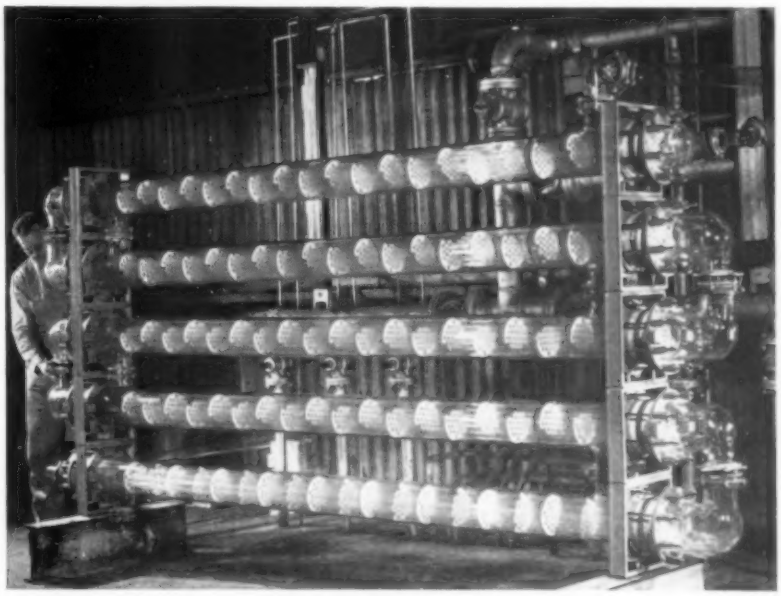
FOR DESIGN ENGINEERS No. 37

Heat Resistant Silicone Enamel Improves Space Heater, Cuts Costs

Paints and enamels made with Dow Corning Silicones not only solve the problem of keeping an attractive finish on hot metal surfaces, but frequently effect noteworthy savings in production costs as well. For example—

Five years ago, Temco, Inc., Nashville, Tenn., switched from a vitreous finish to a silicone enamel for the upper grille of their gas-fired wall heaters. The heater normally operates at 350 F, but a blocked flue can quickly boost this temperature to 500 F. Temco has used the silicone enamel on over 25,000 units without a single customer complaint about loss in color, gloss or adhesion.

(Cont. Pg. 2)



Silastic Seals Help Make Glass Heat Exchangers Maintenance-Free

With superior resistance to heat and compression set, Silastic* — the Dow Corning silicone rubber — has helped Corning Glass Works to engineer low maintenance into their new Pyrex modular shell-and-tube heat exchanger.

Mass produced for off-the-shelf delivery, these glass heat exchangers are designed for processing corrosive and metal-sensitive liquids. Any number of standard sections can be combined into a single, efficient heat exchange unit. Maintenance is almost nil due to the glass construction and the efficiency of a Silastic seal between the shell and tube.

Here's how it works: a resilient Silastic gasket is put under pressure by tightening the flange bolts of the sections. Completely contained between the tubes and a retainer ring, the Silastic in turn, forces a Teflon "protector" sheet to form a permanent, leakproof seal against the tube ends. Resilience and positive pressure are maintained by the Silastic part despite expansion and contraction at operating temperatures as high as 375 F.

*T.M. REG. U. S. PAT. OFF.

(Cont. Pg. 2)

Silicones Assure Top Performance of Mercury Outboard Motors

New evidence to the versatility of Dow Corning silicone compounds comes from Kiekhaefer Corp., Fond du Lac, Wisconsin, manufacturer of the "Mark 75," world's most powerful production outboard motor.

To help keep this and the other eleven new Mercury motors in top operating condition despite rugged service, Kiekhaefer coats several rubber, ceramic and metal parts in every motor with a paste-like silicone dielectric compound. Exceptionally resistant to heat, cold, oxidation and moisture, the silicone compound protects and preserves rubber, serves as a light lubricant, and helps prevent shorts in the electrical system. Since this Dow Corning silicone compound remains serviceable from —70 to 400 F, it stays in place under adverse conditions to minimize maintenance and to assure long, trouble-free service. **No. 376**

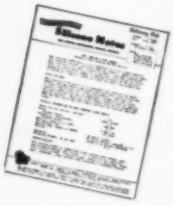
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Shell Molding with silicone parting agents is described in a new, illustrated "how-to-do-it" brochure. Included are recommendations for cleaning and breaking-in patterns, and suggestions for getting continuous, easy release of shell molds with high dimensional accuracy. *No. 380*

Silicone Materials in Appliance Design, a recent article in ELECTRICAL MANUFACTURING, lists a variety of applications for several different silicones in appliances; describes how silicones have made possible design changes heretofore impractical, and how they extend service life and dependability. To receive your copy, circle *No. 381*

Silicone Coatings for Metal Products. An article reprint from MATERIALS AND METHODS provides a comprehensive review of current uses for all types of silicone finishes now available. Includes information on coverage, costs, and methods of application. A valuable aid in selecting the most suitable type of silicone finish for any particular application. *No. 382*

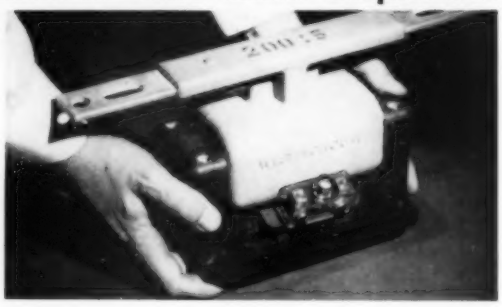
Silicone Shoes for Brakes, reprinted from PRODUCT ENGINEERING, tells how the B. F. Goodrich Company solved a critical problem in aircraft brake design by using braking shoes molded from Dow Corning 301 Molding Compound. 301 Compound was selected because it will withstand the intense heat — up to 1500 F developed at the brake lining surface. *No. 383*

Silicone News Comes Alive—at Design Engineering Show, May 20 to 23. Make a note now to visit Booth 406 on the first floor of the New York Coliseum on these dates. See silicones at work in a wide variety of design applications. Meet our technical representatives and discuss how silicones can help solve some of your design problems. *No. 384*

Engineering brochure on Silastic 50 and 80; includes detailed information on these two general purpose silicone rubbers; provides a convenient reference for design and production engineers. *No. 385*

Protect Current Transformer With Silastic Encapsulation

Encapsulation in Silastic*, Dow Corning's silicone rubber, has proved to be an ideal solution to the problem of protecting electrical and electronic components from vibration, heat, moisture and corrosive conditions. An excellent example is found in the new Type 5-kv current transformer made by Westinghouse.



A highly compact unit designed for indoor metering or relaying applications, the SM-5 transformer is the smallest, lightest and most durable 5-kv unit ever built. Silicone insulated throughout, the SM-5 easily meets all ASA and NEMA standards.

To further assure top dependability, the entire core-coil assembly is encapsulated in an attractive, one-piece silicone rubber jacket. This jacket remains resilient and retains its original dielectric properties even in locations subject to extreme changes in temperature and humidity. The silicone rubber also expands and contracts with the coil. As Westinghouse aptly describes it, "transformer performance is sealed in to stay." *T. M. REG. U. S. PAT. OFF. *No. 377*

SILICONE ENAMEL *(Cont.)*

Because the silicone coating remains flexible and does not require high-temperature firing, production savings have been tremendous. Rejects due to chipping and warping have been virtually eliminated. Even handling and shipping costs have been reduced.

The enamel used in this application is a brown Sicon finish formulated with Dow Corning Silicones by Midland Industrial Finishes Company. A single coating is sprayed on the steel grille and baked for 20 minutes at 350 F. *No. 378*

SILASTIC SEALS *(Cont.)*

That's the kind of serviceability you can expect from seals backed by these typical Silastic properties:

• Temperature range, F	—130 to 500
• Tensile strength, psi	600 to 900
• Elongation, %	150 to 300
• Tear strength, lb/in	40 to 75
• Compression set, %, at 300 F	25 to 50
• Hardness range, Durometer	20 to 80
• Weather, ozone and corona resistance	Excellent

No. 379

CLASS H MOTOR STILL ON TEST AFTER 62,672 HOURS AT 240 C

At 10 A. M., June 3, 1946, a Class H insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since the test began, the motor has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A.M. March 1, 1957, this motor was still on test after 62,672 hours at an average copper temperature of 240 C! That's equivalent to 383 years operation at the Class H temperature of 180 C.

Most electrical equipment manufacturers offer silicone (Class H) insulation in new equipment. Over 200 leading motor repair shops offer silicone rewinds for motors, generators and transformers at little or no premium over Class B insulation.

Dow Corning Corporation, Dept. 8616, Midland, Michigan

Please send me: 376 377 378 379 380 381 382 383 384 385

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE STATE _____

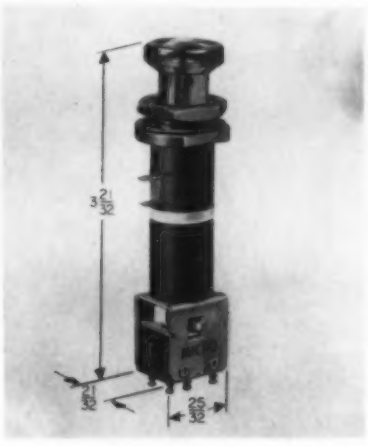
SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones

DOW CORNING SILICONES

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C.
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD. LONDON FRANCE: ST. GOBAIN, PARIS



overcenter snap-action, provide exceptionally reliable operation. The switches are UL-listed at 5 amp, 125 or 250 v a-c. Micro Switch, Minneapolis-Honeywell Regulator Co., Freeport, Ill.

For more information—
Circle 50, inside back cover

Accelerometer Fits $\frac{3}{8}$ in. Hole

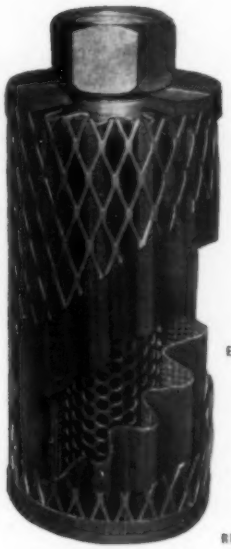
This accelerometer, 0.635 in. high, provides 5 milliv per G sensitivity, with a natural frequency of 50,000 cps. Temperature characteristics are flat ±10%, from −30 F to 230 F. Weight is 8 g. Endevco Corp., 161 E. California St., Pasadena, Calif.

For more information—
Circle 51, inside back cover

Differential Pressure Control

Each of this unit's two switches has a separate adjustment screw that is uncalibrated. The switches become actuated when the pressure on the high side exceeds the pressure on the low

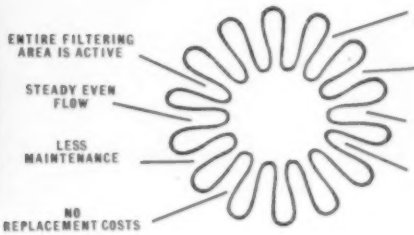
(Continued on page 244)



SUMP TYPE (cutaway)

When You Need A Filter— Get The Advantages of MARVEL'S SYNCLINAL DESIGN It's Balanced For Top Performance!

Look For These Important Features



For All Hydraulic and Other Low Pressure Liquid Systems

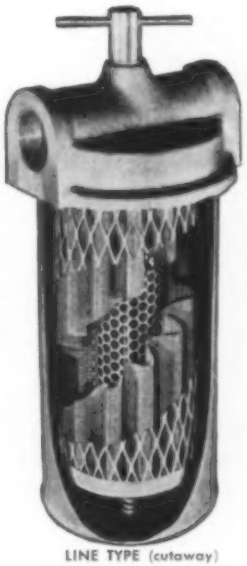
In the selection of a filter to obtain maximum efficiency and quality, the most important point to consider is a specific type filter that will offer greatest ACTIVE filtering area with ample storage capacity for filtered out particles, rather than total filtering area alone. Over 750 Original Equipment Manufacturers install Marvel Synclinal Filters as Standard Equipment because they are designed to give this all-important balance for greatest efficiency in filtration of liquids in all hydraulic and other low pressure circulating systems. Flow of liquids is maintained at a constant, steady rate of speed produced by the pump which brings about the desired effect of a gentle, evenly distributed accumulation of filtered out particles against the entire filtering surface with less restriction of flow. Result—longer periods of productive operation at minimum maintenance down-time. If this important balance is lacking due to efforts to cram too much filtering mesh for the sake of total rather than active area, filters soon become clogged causing pressure build-up, turbulent flow and in general decreases the efficiency of operating equipment. Depend on Marvel Synclinal Filters For All Your Filtration Requirements.

EASY MAINTENANCE

Both sump and line types may be easily disassembled, cleaned and reassembled by any workman, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation as described in catalog. Choice of Monel mesh sizes range from coarse 30 to fine 200.



LINE TYPE (cutaway)

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

Catalogs containing complete data available on request.

IMMEDIATE DELIVERY!
As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

MARVEL ENGINEERING COMPANY
7227 N. Hamlin Ave., Chicago 45, Ill.
PHONE: JUniper 8-6023

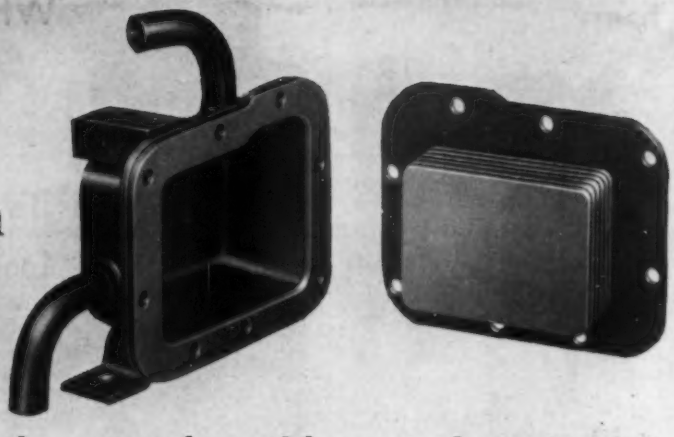
PE-4

Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated—

- ☐ Catalog #107—For Hydraulic Oils, Coolants, Lubricants
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

Name .....
Company .....
Address .....
City .....
State .....

Better Engine Operation with Oil Coolers



Heat dissipation in limited area accelerated by new, plate-type unit

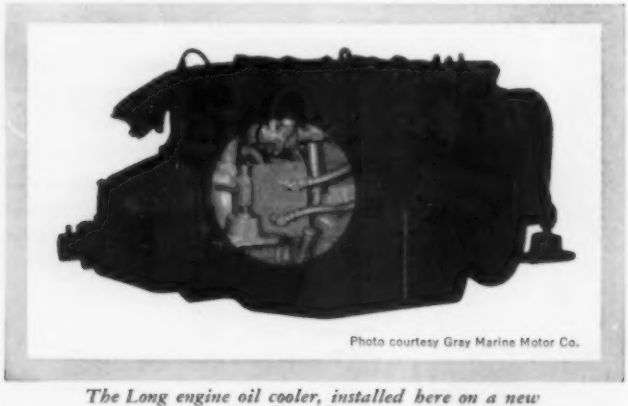
The ever higher performance being built into modern engines is creating new problems in heat dissipation. Engine efficiency, pressures and operating speeds have increased. So have operating temperatures of the engine parts. But the surfaces and area available for dissipating heat may be unchanged or even smaller. Therefore, more heat is drawn into the lubricating oil of the engine.

Although friction losses in percent of total power output are dropping, the absolute rate of heat generated has gone up. This heat may exceed temperatures which the bearings are designed to resist and may rise to destructive levels.

In commercial vehicle, marine and industrial engines, heavy work loads are usually frequent or constant enough to require an oil cooler to maintain viscosity and to augment heat rejection. Such a unit may be attached to the engine or built into the engine block.

LARGE CAPACITY IN SMALL UNIT

To facilitate concentrated heat dissipation in a small space, Long Manufacturing Division of Borg-Warner Corporation has developed a compact, plate-type heat exchanger with large heat rejection capacity for its size. The unit is applicable on or in any engine requiring lubricant cooling. Current applications extend to 400 btu/pm. The element's rectangular shape is proportioned to be readily adaptable to a small aperature in the block where water can be circulated.



The Long engine oil cooler, installed here on a new marine engine, is small, unobtrusive, easily accessible.

It can also be used for any oil cooling application, such as in transmissions, torque converters and hydraulic presses.

The high efficiency of this cooling element lies in the diagonal flow path of the oil across the plates, utilizing the maximum possible length of the unit. Location of the fittings gives high velocity turbulence and effective oil distribution.

Spacers are placed between the plates to allow free circulation of the cooling water around this core. The assembly is then brazed into an integral structure. Counter-flow paths of the oil and water assure maximum heat exchange efficiency.

The turbulators are designed to minimize the pressure drop across the plates. Ingenuity in designing flow paths and stack arrangements of a single design element, according to the operating requirements, contributes to the economy of the unit. Any reasonable number of plates may be assembled in parallel, in series, and in parallel series.

RUGGEDNESS AT LOW COST

Manufacturing the casing (in accessory applications) from steel stampings instead of fabricating it from castings is a unique, cost and weight saving feature. Paint protects the exterior while the waterside is clad with rust- and corrosion-resistant cupronickel. The plate shells enclosing the mild steel turbulators are formed from stampings of solid cupronickel.

On the waterside this heat exchanger may be readily cleaned and the multiple-plate core can be removed from the casing without disturbing the water connections.

Traditional Long engineering and craftsmanship assures the quality, efficiency and dependability of this oil cooler. It is the first in a series of new products from this 53-year old manufacturer of heat exchangers, clutches and torque converters.

An engineering bulletin, including basic heat transfer and pressure drop charts from performance tests at Long Laboratories, may be had on request. The data also lists information requirements for obtaining recommendations on specific applications of this and other types of oil coolers.

Write to Dept. OC 1, Long Manufacturing Division, Borg-Warner Corp., 12501 Dequindre Street, Detroit 12, Michigan. In Canada: Long Manufacturing Company Limited, Oakville, Ontario. Export Sales: Borg-Warner International, 36 South Wabash Street, Chicago 3, Illinois.

FAST, HAMMER-DRIVEN RIVET ECONOMICAL FOR BLIND AND OPEN APPLICATIONS

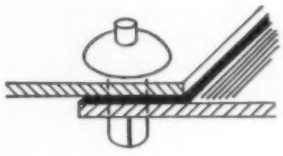


Fig. 1 Inserted in hole, Southco Rivets are quickly set by driving pin with hammer. No special tools are required. Bucking is not necessary.

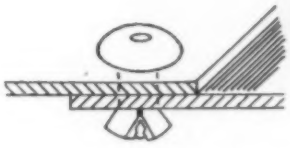


Fig. 2 Expanded prongs force sheets or parts together, hold them tightly in compression. No metal is removed, no grinding or finishing is required.

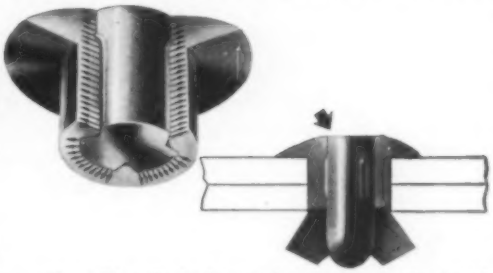


Fig. 3 Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

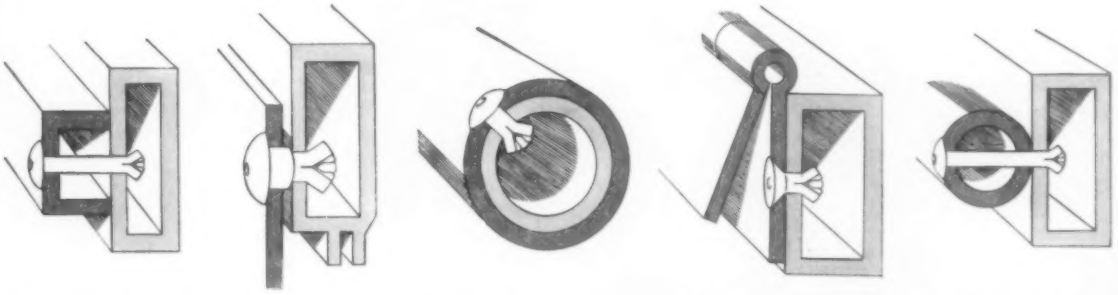


Fig. 4 Ideally suited for "blind" applications, Southco Rivets are worked by one man from one side only and require minimum space inside closed area. They eliminate costly bucking arrangement or time-consuming finishing. Supplied as a unit, they require no job time for assembly or fitting.

Fig. 5 Access or open fastening utilizes the simplicity, speed and vibration-resistance of Southco Rivets.

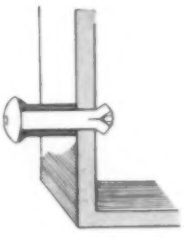


Fig. 6 Ferrules are used as spacers for numerous applications. Here the Southco Rivet forms a drawer pull in conjunction with a flanged tube.

Fig. 7 Increased head size distributes holding pressure over larger area, permits higher loading on wood, plastics and similar materials.

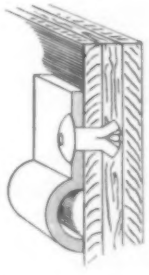
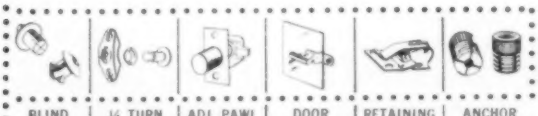


Fig. 8 A blind head can be formed inside the wood. This application is particularly useful when it is desirable to have one surface of the wood unmarred.

FREE!
Fastener Handbook

Send for your free copy of Handbook No. 7. Complete data for designers on these and many other specialty fasteners. 52 pp., two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pennsylvania.



SOUTHCO FASTENERS
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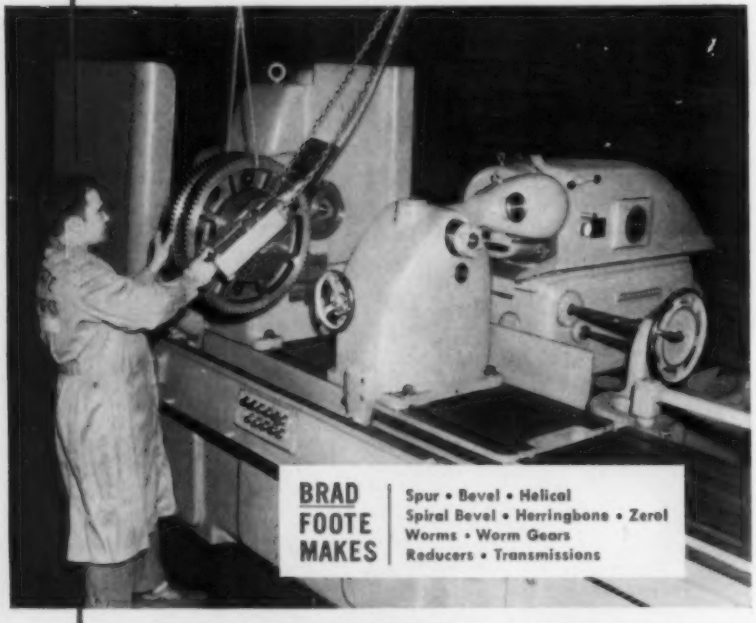
LION

SPECIAL MACHINES —MEN

2 Reasons Behind Brad Foote Quality

• The craftsman shown below is loading a gear into one of the latest additions to BRAD FOOTE'S long list of special-purpose machines. The only one of its kind in existence, this new shaver can straight or crown shave gears up to 51" in diameter. Normally accommodating gears with shafts up to 142" between centers, it can handle even longer shafts by using special journals. Specially designed, the new machine will shave either internal or external gears.



• Costly special machines such as this are important in providing the extra quality at lowest cost which is the hallmark of BRAD FOOTE gears. But these are only part of the story. Even more important, perhaps, are the men who man these machines—experienced craftsmen with long experience in producing gears to meet the most exacting and specialized requirements.

• BRAD FOOTE'S facilities are at your disposal whether you need one gear or a long production run. We would sincerely appreciate an opportunity to discuss your requirements or quote on your specifications. Your inquiry will receive prompt attention.

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Bishop 2-1070 • Olympic 2-7700 • TWX: CIC-2856-U

subsidiaries

AMERICAN GEAR & MFG. CO.
Phone: Lemont 920
Lemont, Illinois

PITTSBURGH GEAR COMPANY
Phone: SPalding 1-4600
Pittsburgh 25, Pennsylvania

by the preset amounts, regardless of the static pressure value. Switches may be set together to simulate double-pole circuitry or set apart to obtain independent operation. Wider limits of differential between switches are obtainable.

Seven models are offered with various system differentials up to 90 psi. On-off switch differentials between the limits of 1 in. Hg and 5 psi are obtainable.

The control is available in any one of three standard types of switches: normally open, normal closed, or double-throw with no neutral position. Switches are rated up to 15 amp at 115 or 230 v a-c-d-c, and 20 amp a-c switches are also available. The switch is wired to screw terminals on switches through a clearance hole in the enclosure.

The bellows is made of brass, Monel or stainless steel, dependent on the model. United Electric Controls Co., 79 School St., Watertown, Mass.

For more information—
Circle 52, inside back cover

Speed-Sensitive Speed Control

A variable speed drive, said to be capable of maintaining any speed in its range within 0.25% regardless of load fluctuations, consists of a variable speed motor and an automatic control package. This pneumatic device operates on a tight-loop, high-response, feed-back principle.

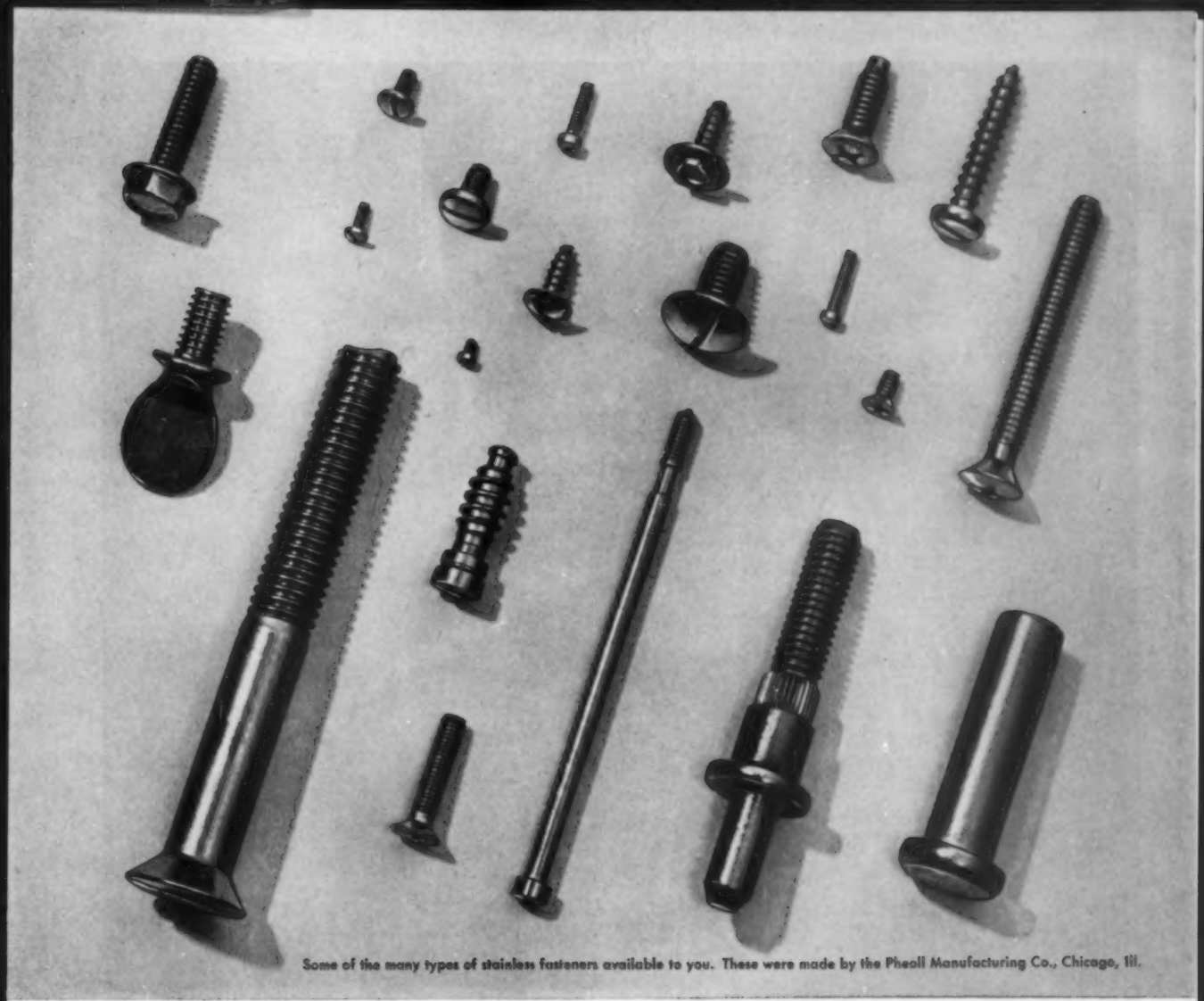
These control units are available with ratings of 1 to 60 hp. U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 53, inside back cover

Thyratron Amplifiers

Packaged thyratron amplifiers for use in power control devices have tube ratings from 2.5 through 18 amp output current, single-phase, two-phase and three-phase. They can be connected for back-to-back, one, two or three half-wave operation and bridge circuits. The units are designed for vertical panel board mounting. Any type of motor drive positional servo, lighting or heating controller can be

(Continued on page 247)



Some of the many types of stainless fasteners available to you. These were made by the Pheoll Manufacturing Co., Chicago, Ill.

How stainless steel fasteners make a better product at lower cost

Performance and appearance get a boost when you use stainless steel fasteners. For stainless resists rust, heat and corrosion. It keeps its good looks for a lifetime. Stainless-fastened products won't be marred by unsightly rust streaks—and they can be dis-assembled and assembled quickly and easily even after years of all-weather service.

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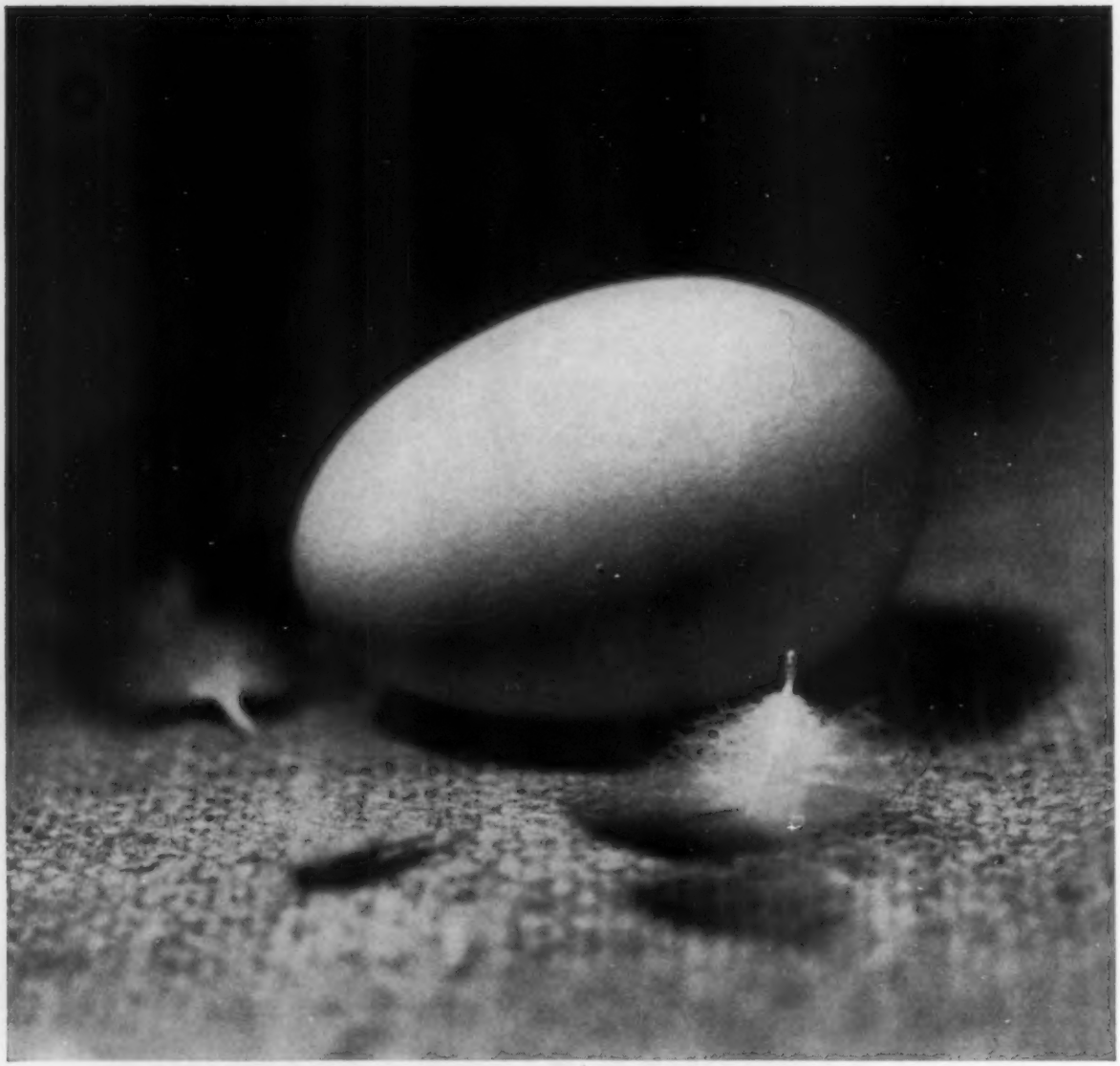
You cut tooling costs, too. For now stainless fasteners are promptly available in just about *any* size or description—and in any of the 200, 300, or 400 Rezistal stainless series. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

PRODUCTION MEN: If you use stainless steel cold heading wire, Crucible can fill your needs quickly and dependably. It is regularly supplied in all diameters and standard grades, and in a variety of finishes. For more information write for your free copy of the 32-page booklet, "Rezistal Stainless Steel Wire."

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.



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FLINT—Kober Sales Engineering Co., 1115 Root St., CEdar 2-7165
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MECHANICAL AIR CONTROLS, INC.
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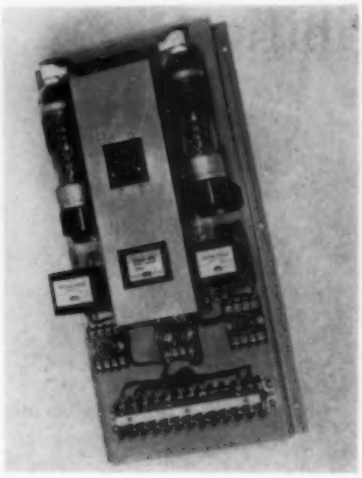

put in operation by connecting control elements, control voltages or currents, load and feedback transducers. These amplifier units are shipped complete with packaged grid circuits, circuit breakers, warm-up time delay, spare plug-in sockets, power transformer and tubes. Hanson-Gorrill-Brian Inc., 85 Hazel St., Glen Cove, N. Y.

For more information—
Circle 54, inside back cover

Re-Rated, Fan-Cooled Motors

These motors are completely protected against moisture, dust and corrosive atmospheres. Steel parts and cast iron end heads are given an anti-corrosion treatment. The die-cast aluminum motor is sprayed with a special rust inhibitor, which covers the entire assembly, including the shaft. Flange mountings of the standard NEMA C face type are available.

The motors are available in ratings from ½ to 40 hp. Frames run 182 through 405. Robbins & Myers, Inc., Springfield, Ohio.

For more information—
Circle 55, inside back cover

Permanent Magnet Synchronous Motor

Guaranteed torque of 30 in-oz at 1 rpm and a selection of speeds from 60 rpm to ¼ rev per deg are provided in these motors. A variety of output shaft dimensions are available. Instant start and stop, low input (approximately 3.25 w) and permanent lubri-

(Continued on page 248)

How Alcoa Aluminum Fasteners make good furniture even better

With your good name riding on every aluminum chair, chaise and settee, it pays to assemble with Alcoa® Aluminum Fasteners. You get perfect color match and lasting good looks with absolute protection against both galvanic and atmospheric corrosion. Your local Alcoa distributor has a complete stock of aluminum fasteners to meet your every need. He is listed in the Yellow Pages of your telephone directory.

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Here is a steel tape that stays clear and legible long after markings on other tapes have worn off.

An amazingly tough plastic coating on both sides of the line protects the white background, the graduations and numbers on ALBADURE tapes, giving their surfaces tremendous resistance to abrasion and corrosion. To quote a State surveying party report, "If ALBADURE stood up in this tough mud and sand, it'll stand up anywhere." Available in all standard lengths, widths and graduations, in cases and on reels.

PHOENIX WYTEFACE®... the woven tape that outlasts others 3-1

PHOENIX WYTEFACE (non-metallic) Woven Tapes made from extra strong synthetic yarns, are harder wearing, with higher tensile strength and dimensional stability than ordinary woven tapes. A special plastic coating on both sides protects the line against hard use, water, stones or brush.

The end of the line is enormously strengthened by a lamination of Flexi-Foam, a spongy plastic-rubber. No stitches or hinge point to weaken the line.

A Highway Engineer reported of the non-metallic PHOENIX WYTEFACE, "It has at least three times the life of an ordinary metallic tape." *Ask Your K & E Dealer!*

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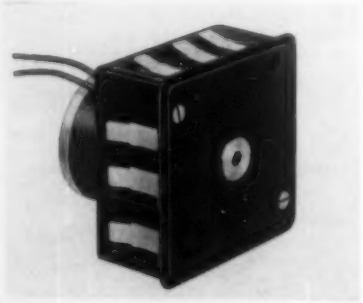
cation are other design details. The motor is for operation on all standard a-c voltages, 60 and 50 cps. Motors measure 1⅞ in. in depth. Cramer Controls Corp., Centerbrook, Conn.

For more information—
Circle 56, inside back cover



Cycling Timer

With contacts for 30-amp resistive loads (and ½ hp) at 115 v a-c, speeds of 1 rpm to 1 rev in 8 day are available with this container. Switches are open blade, either single-pole, single-throw or single-pole, double-throw. Three-level cams and a neutral position in the switches can be supplied to permit control of up to eight load circuits with a four-pole timer.

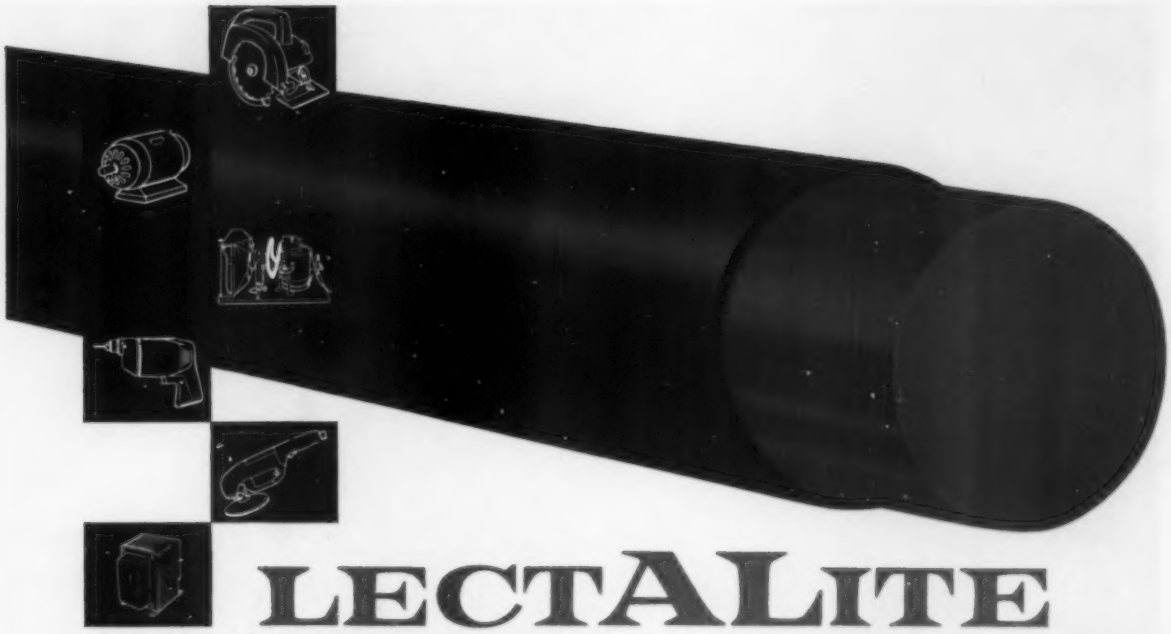
Overall dimensions are approximately 2¾ x 2¾ x 2¾ in., including motor. The timer is available for operation on all standard voltages, 60 and 50 cps. Cramer Controls Corp., Centerbrook, Conn.

For more information—
Circle 57, inside back cover

Acceleration and Speed Controller

Acceleration and speed control of shunt wound, d-c motors ranging from 1/50 to ¼ hp, is provided. The motor

(Continued on page 252)



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LectALite Magnet Wire has been tested in accordance with AIEE 57 and MIL-W-19583 thermal aging test and found to be acceptable for Class B applications. LectALite is available in copper, aluminum, steel or silver. Ideal for small electric motors, transformers, and TV yoke coils. Extreme resistance to Freon 12 and 22 and low extractables make it outstanding for hermetic refrigeration motors.

LectALite opens new magnet wire fields throughout the electrical industry.

LectALite Wire is protected with insulation which offers more heat resistance, higher thermoplastic flow, higher dielectric strength, greater flexibility and lower extractables than vinyl acetal insulation—with no increase in cost! Now available in sizes from 13 AWG through 30 AWG.

Tests indicate LectALite Wire is superior for use in hermetic refrigeration motors due to its outstanding Freon 12 and 22 resistance plus low extractables. LectALite Wire insulation has been found to have 30°C. margin over vinyl acetal insulation by test performed under AIEE N. 57, Oct., 1955, "Proposed Test Procedure for Evaluation of the Thermal Stability of Enameled Wires" and MIL-W-19583 (NAVY) "Military Specification Wire, Electrical, Magnet, High Temperature, Film Insulated," July 15, 1955. Impregnation of LectALite wound coils can be done by any phenolic-alkyd type or suitable temperature rated impregnation varnishes.

The Auto-Lite Magnet Wire line is complete in classes O, A, B, and H to meet your design requirements. Fill out coupon and mail for further information.

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"Darkroom test* proves raw camera castings

High precision of Doehler-Jarvis make new cameras light-tight

Revere-made Wollensak "43" 8 M/M spool-type turret camera. Built-in filters provide finger-tip adjustment for three conditions: (1) clear shooting (2) haze (3) outdoor shots with indoor film.

Lights! Camera! Action . . .

Our hero (in darkroom above) has just snapped together the three die castings that house the new Revere-made home movie camera shown left . . . snapped them together around a tell-tale light.

The castings are raw . . . just as they come from Doehler-Jarvis. Notice no light escapes where the housing parts join. *Even before machining, the seal is light-tight.*

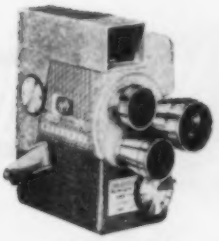
That's precision for you. The kind Revere Camera Company expects and gets from Doehler-Jarvis.

What's more, each casting provides, "no-tolerance" machining base points. From these points Revere establishes all basic dimensions for machining of the camera mechanism. They get an accuracy so high they can afford to offer a lifetime guarantee on the action.

Realizes many design advantages

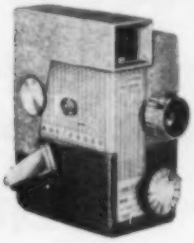
Revere designs from the start to take full advantage of die casting. In most models, for example, Doehler-Jarvis is called in while units are still in the hand sketch stage.

In this instance, details worked out include the use of lightweight magnesium; ways to reduce wall thicknesses (they're way thinner than ADCI minimums); location



Wollensak "43"
8 MM Spool-type Turret Camera

Wollensak "815"
Automatic Slide Projector, 2x2



Wollensak "42"
8 MM Spool-type Cine Camera

Wollensak "715" 8 MM
Movie Push-button Projector

Wollensak "23"
8 MM Magazine Turret Camera

Wollensak "10"
Stereo Camera

*Darkroom test illustrates precision of the raw Doehler-Jarvis die castings as received for use in the above Revere-made Wollensak cameras and equipment. Revere subjects the finished cameras to a much more severe 4-hour direct sunlight test. You can be *sure* they're light-tight.

fit so closely light doesn't pass..."

die castings helps Revere even before machining

of bosses, lugs, corner reliefs; extra back-up for stressed sections; tool-ups for machining and finishing; interchangeability between this and other models. All this pushes ultimate costs down, quality up.

Net result is an outstanding camera that is proving itself on the sales counter.

Doehler-Jarvis die-casts parts for all Revere-made cameras and projectors, not only their name line, but also Wollensak and other brands. Asked why they prefer die castings made by Doehler-Jarvis, Revere put it very simply: "rejects almost zero" . . . "likewise salvage" . . . "D and J people live with our jobs".

Right now Doehler-Jarvis people are "living with" the jobs of some 1400 major users of die castings. They'll do the same for you.

Doehler-Jarvis
DIVISION OF NATIONAL LEAD COMPANY
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Hamilton, Ontario

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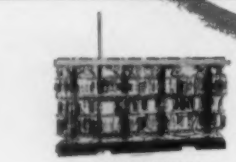
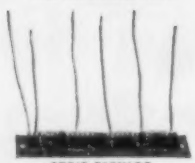


PLUGGABLE UNIT

COMPONENT PACKAGES CAGE ASSEMBLIES

RAIL PLUGGABLE UNITS



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- **TRAINED PRODUCTION PERSONNEL . . .** Trained production personnel is available immediately without the burden of training costs.
- **WELCOME CONSULTATION . . .** Contact ERIE representative for possible economies to be gained through use of our facilities.

Write for complete information about our facilities and Engineering Bulletin 453 describing typical ERIE assemblies.

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can be started at any speed from 1 to 2200 rpm, either immediately or gradually over a ½-min. interval. Motor speed may be accurately and steplessly varied by as little as 220 rpm.

The controller operates on one thyratron tube that automatically increases voltage to compensate for additional loading of the motor armature. Gerald K. Heller Co., 1819 Industrial Road, Las Vegas, Nev.

For more information—
Circle 58, inside back cover

Trimmer Potentiometer

The housing and shaft are stainless steel. The standard dielectric breakdown on this potentiometer is 1,000 v, rms. A 300 megohm insulation resistance to ground at 100 C is standard. The unit will dissipate 2 w of power at 40 C.

Mechanical stops are provided to allow a nominal 310° mechanical rotation. Sturdy stop pins used in this trimmer allow 4 in-lb of torque to be

(Continued on page 257)

Design "Low Cost" Into YOUR Equipment

GITS

World's Largest Selection of Low-Cost Lubricating Devices

LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
Just $14.95 F.O.B. Factory
Satisfaction or your money back

CLIPS FOR ATTACHING TUBING

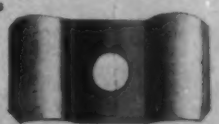
When ordering, specify ⅛", 3/16" or ¼" tubes. Style TF.

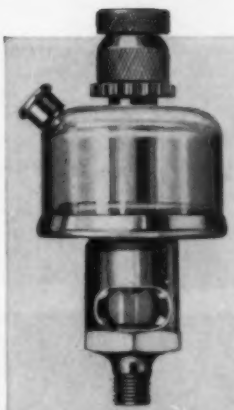
Single Clips

Double Clips

3-Tube Clips

4-Tube Clips


Double Clips — Wing Type



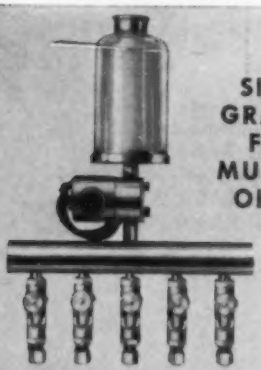
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem.

Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES

For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.

The Standard For Industry For Almost Half A Century

1838-A South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"

How Creative Spring Engineering Aids Automation...

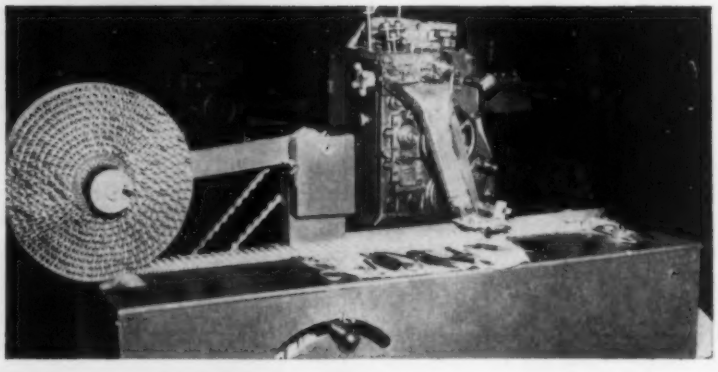
ASSOCIATED SPRING CORPORATION
COAST TO COAST

"Designed Deliveries"

engineered by Divisions of Associated Spring Corporation can be time and money savers for spring users.

Continuous coiled springs are notched at intervals—individual units broken off as needed. (Where precision ends are not required.) *Lower left corner:* Small terminal plugs supplied in strips, also notched for ease in use at assembly line.

Small open coiled springs fed from coiler into valleys of corrugated board strip. Roll at left is ready to ship—springs arrive safely—untangled.



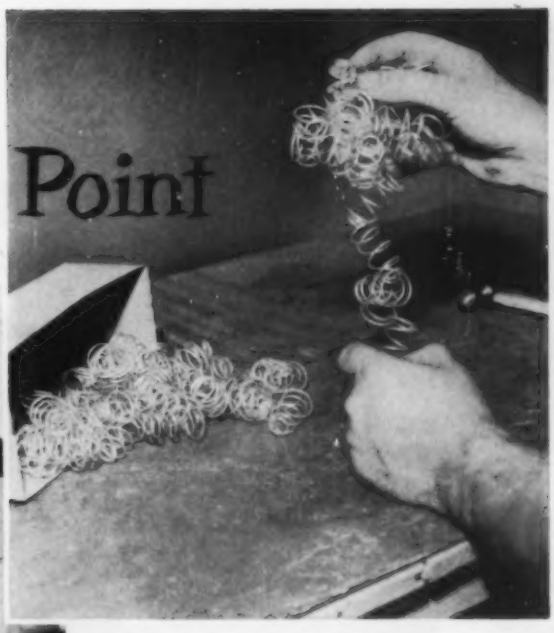
S705

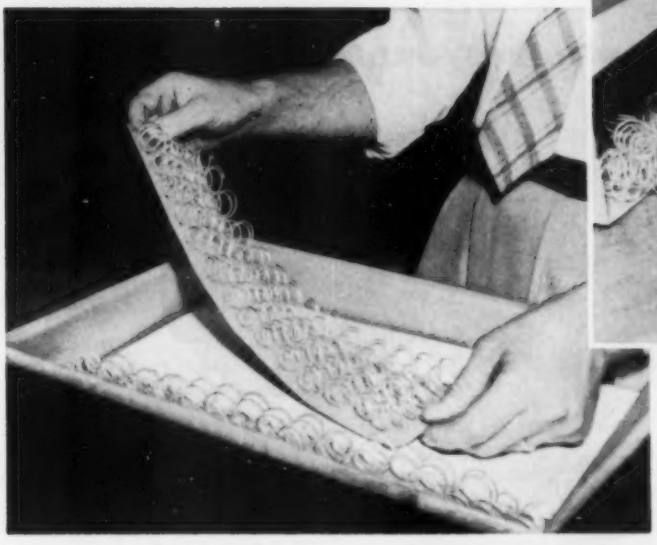
© 1957 ASSOCIATED SPRING CORPORATION
BRISTOL, CONN., U.S.A.

Delicate wire heater elements are caught on a flat steel strip from machine—inserted in plastic tube which protects from distortion and atmosphere. Ready for automatic feeder in customer's assembly setup.

Divisions of

at the Assembly Point





Before-and-after views show tangle of springs in bulk shipment—and same springs held on layers of pressure-sensitive tape ready for instant selection.

Tiny hairsprings for precision electrical meters are nestled in recessed pads, avoiding distortion from contact in shipment or storage at point of use.

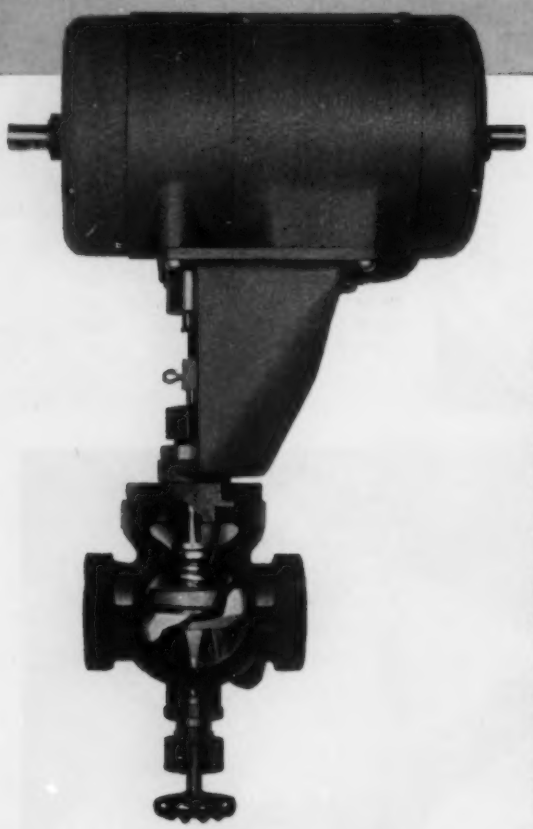
Do these examples suggest an approach to your spring problem? Write for pamphlet "M T M," giving further information.

ASSOCIATED SPRING CORPORATION

GENERAL OFFICES: BRISTOL, CONNECTICUT

NEW ACTIONATOR*

heavy duty electric motor for operating valves, dampers, louvers



The new Honeywell ACTIONATOR* is a compact, lightweight, rugged and flexible industrial motor for operating valves, dampers, louvers, and other final control elements. Models for boss mounting or with integral valve yoke for installation on slip stem valves. Internal strain release protects valve seats and gear train. Squared shaft ends facilitate actuating lever attachment.

The ACTIONATOR is available in reversing or unidirectional models for on-off or two-position control, and in reversing models for floating or proportional control. Shaft rotation can cover up to 350 degrees in 7½, 10, 15, 30, 60, or 120 second timings, depending on model; torque ratings to 200 pound-inches, depending on motor speed.

The proportional control model provides slidewire resistances of 135, 500 and 1000 ohms, and can be used with any type of proportional controller. A second slidewire can be used for retransmission, to operate another motor, or for remote indication. If preferred, SPST and SPDT auxiliary switches can be installed within the end bells. The enclosed terminal compartment is designed to meet J.I.C. standards.

Specially designed MICRO SWITCH switches allow the ACTIONATOR to be used where ambient temperatures range from 25 to 150 F.

For complete information and specifications on the new ACTIONATOR, call the nearest Honeywell office, or write (send coupon) to:

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.

Industrial Division
MINNEAPOLIS-HONEYWELL REGULATOR CO.
Wayne and Windrim Avenues, Philadelphia 44,, Pa.

☐ Please send me additional information on the ACTIONATOR.

☐ I'd like a Honeywell sales engineer to discuss applications of the ACTIONATOR in my plant.

Name_____

Title_____

Company_____

Address_____

MINNEAPOLIS Honeywell

First in Controls

*Tradename Minneapolis-Honeywell Regulator Co.

exerted on the shaft. The potentiometer is available from stock in standard resistance values of 25 to 50,000 ohm. Maurey Instrument Corp., 7924 S. Exchange Ave., Chicago 17, Ill.

For more information—
Circle 59, inside back cover

Teflon-Insulated Wire

These wires include both extruded and wrapped types, sizes 16 through 30, with Teflon insulation covering in 10 colors. Available in 10, 25, 50, 100, 250, 500 and 1000-ft lengths. Alpha Wire Corp., 200 Varick St., New York 14, N. Y.

For more information—
Circle 60, inside back cover

Circuit-Breaking Receptacles, Plugs and Connectors

A choice of two grounding arrangements is offered to meet varying service conditions or locations. All devices are polarized, so that plugs will fit only into receptacles or connectors having the same electrical characteristics.

These units are made of cast aluminum alloy housings and enclosures, rated 30, 60, 100 and 200 amp, 60 v a-c, or 250 v a-c or d-c. Russell & Stoll Co., Inc., 125 Barclay St., New York, 7, N. Y.

For more information—
Circle 61, inside back cover

Motor-Pump Unit

A motor-pump combination has been designed for 6 and 12-v battery-operated equipment such as vehicles, lift trucks, snow plows, tail gate lifts and graders. The unit measures 12⅜

(Continued on page 260)

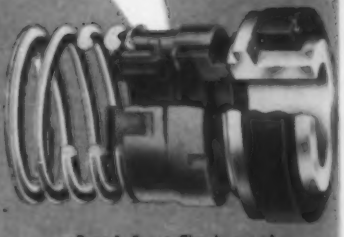
YOU insure
RUGGED FIELD PERFORMANCE
plus PRODUCTION SAVINGS

when you specify these
JOHN CRANE MECHANICAL SEALS

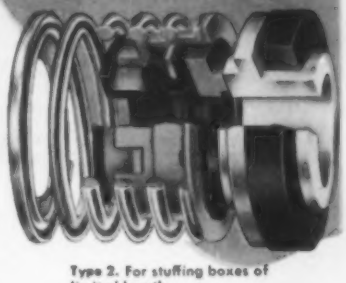
"JOHN CRANE" Types 1 and 2 shaft seals come pre-assembled. They are quickly and easily installed. Tolerances need not be critical due to the self-adjusting seal head. This is accomplished through special construction of the synthetic rubber bellows head. Moving freely under spring and hydraulic pressure, it automatically compensates for shaft end play, as well as washer wear.

Sealing faces are precision-lapped to prevent stuffing box leakage. No break-in runs necessary. Positive drive feature eliminates all stress on bellows. This feature also permits the use of light spring load to minimize wear on sealing faces. Seal needs no attention over long periods of operation.

Recommended for water, oil and other services non-injurious to synthetic rubber. Pressures to 200 psi. Temperatures: -40° to +212°F.



Type 1. For stuffing boxes of limited diameter.



Type 2. For stuffing boxes of limited length.

Above seals also available in balanced construction (1-B, 2-B) for pressures up to 500 psi.

Write for Bulletin S-213-1
Crane Packing Co., 6445 Oakton St., Morton Grove, Ill., (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

High "IR" Cold-punching Laminate

INSUROK® XT-896

by Richardson

Here's an all-new Richardson product . . . that will cut your production costs in mechanical assembly and printed circuitry!

New Insurok XT-896 punches sharp and clean at average room temperatures. It is ideal for precision-punching of mechanical and electrical parts since it's not subject to dimensional changes that occur in materials which must be heated before processing.

This XXXP laminate has low moisture absorption, low dielectric loss and excellent insulation resistance. In copper clad form it maintains its bond strength throughout heat cycling and has good blister resistance.

For increased production of automatic assemblies . . . for greater precision in printed circuits . . . specify Insurok XT-896. Call on Richardson engineers to assist you in the application of NEMA, copper clad and special grades to meet your product requirements. A note on your letterhead to Dept. 18 will bring data and samples by return mail. Better still—phone today. Chicago telephone: MAnsfield 6-8900.

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PLASTICS
LAMINATED and MOLDED

The RICHARDSON COMPANY

Founded 1858

2793 LAKE STREET • MELROSE PARK, ILLINOIS

SALES OFFICES IN PRINCIPAL CITIES

TDA® BRAKES

if it rotates...we can control it!

NEW "T" BRAKE

...an economical new air brake designed for a variety of automotive applications

Outstanding control for a modest investment is offered by the new "T" air brake. Ruggedly-built, dependable, and capable of long, trouble-free service, its economy is achieved principally through simpler design and improved manufacturing methods.

Air-actuated, the "T" Brake operates through a precision-forged, one-piece camshaft. The cam design provides a constant, equal rate of lift to both shoes. The entire camshaft is heat treated for maximum strength.

Fabricated steel brake shoes combine strength with lightness . . . hardened spool type cam rollers used with single-web, fabricated shoes provide perfect alignment with camhead. The roller, mounted in an open-type support, is always free to rotate. Brake linings are available up to ½" in thickness.

Other features include: quick, one-point adjustment; air chamber and camshaft brackets mounted on backing plate in one compact assembly; wide range of sizes and capacities.

©1956, R S & A Company

For every industrial, agricultural or automotive application where braking is required!

TIMKEN Detroit BRAKES
ROCKWELL SPRING AND AXLE COMPANY
the Accepted TDA Standard

TDA Plants at: Detroit, Michigan • Oshkosh, Wisconsin Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

Timken-Detroit Brake Division
Rockwell Spring & Axle Company
Dept. PE-47, Ashtabula, Ohio

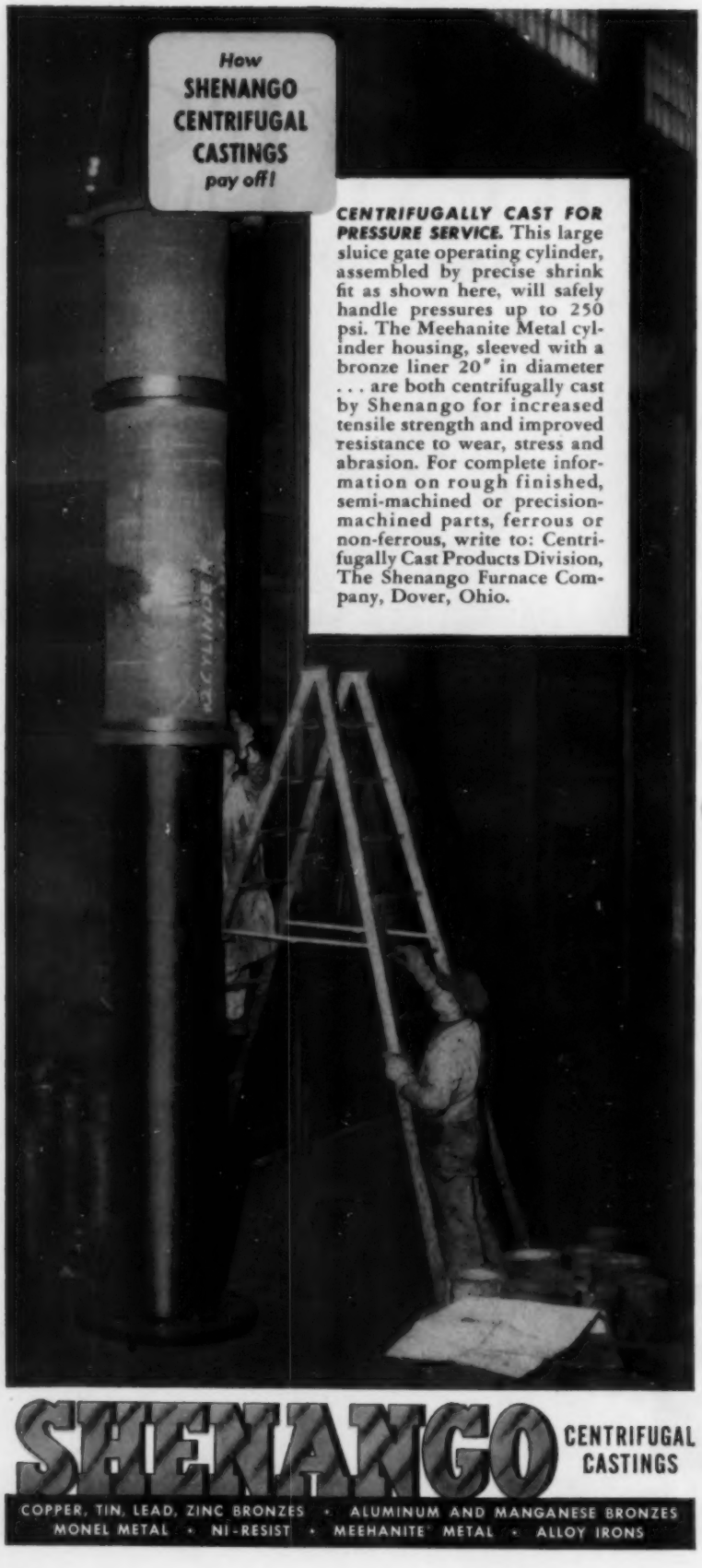
Please send me further information on your "T" Brake.

Name _____ POSITION

Company _____

Address _____

City _____ State _____


How
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CENTRIFUGAL
CASTINGS
pay off!
CENTRIFUGALLY CAST FOR PRESSURE SERVICE. This large sluice gate operating cylinder, assembled by precise shrink fit as shown here, will safely handle pressures up to 250 psi. The Meehanite Metal cylinder housing, sleeved with a bronze liner 20" in diameter . . . are both centrifugally cast by Shenango for increased tensile strength and improved resistance to wear, stress and abrasion. For complete information on rough finished, semi-machined or precision-machined parts, ferrous or non-ferrous, write to: Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.
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CENTRIFUGAL CASTINGS
COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

in. in length, includes a four-bolt foot mounting integral with the motor. The d-c motor can be supplied with stationary or removable brushes. Webster Electric Co., Racine, Wis.

For more information—
Circle 62, inside back cover

Variable Permeance Force Transducer

Variable permeance force or load transducers are said to provide reduced sensitivity to temperature changes. The electrical sensing elements are variable permeance rectilinear transducers. Repeatability is nearly 100%, and resolution is limited only by external circuitry. The transducer senses either compression or tension force without mechanical adjustment. Crescent Engineering & Research Co., 5440 N. Peck Road, El Monte, Calif.

For more information—
Circle 63, inside back cover

High Frequency m-g Set

Push-button control permits automatic adjustment of output frequency of this 5kw a-c motor generator set. A variable pulley arrangement permits adjusting the frequency from 380 to 420 cps.

Output is 380 cps at 3257 rpm, 400 cps at 3428 rpm, and 420 cps at 3600 rpm. The 14-pole, 5000-w alternator supplies three-phase, 120/208 v current. Initial power is furnished by a 7½ hp, 60 cps a-c motor, which operates at 1800 rpm.

(Continued on page 264)

ACP *Granodine*® IS THE BASE FOR SPARKLING, DURABLE PAINT FINISHES ON HOME APPLIANCES

ACP GRANODINE IN HOMES—ranges, refrigerators, freezers, washers and dryers, and many other appliances have sparkling, durable finishes anchored to the metal by ACP Granodine nonmetallic phosphate coating.

ACP Granodine anchors the finish on many home appliances, giving them a sparkling and lasting beauty. It performs the same function on automotive equipment and industrial products by chemically converting steel surfaces to a nonmetallic phosphate coating. It not only greatly increases the adhesion of the finish, but also provides extremely good corrosion resistance, even when used in conjunction with a relatively thin and flexible paint film. Granodine coatings are easily and economically applied to steel surfaces by dipping, spraying or brushing.

AN AUTOMOBILE FINISH must retain its beauty under all weather conditions. ACP Granodine greatly increases the adhesion of the paint to the metal, provides an excellent base for such a finish.

ACP GRANODINE IN INDUSTRY—drums, materials handling equipment, machine tools and many other steel products throughout the plant are protected by a Granodine base which firmly bonds the paint.

LEARN MORE ABOUT ACP GRANODINE. Bulletin 1380 describes the various types of ACP Granodine and gives information which will help you select the proper one for your particular application. Write for your copy today.

CHEMICALS ACP PROCESSES

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICH. • ST. JOSEPH, MO. • NILES, CALIF. • WINDSOR, ONT.

New Chemical Horizons for Industry and Agriculture

RUBATEX ANSWERS AMANA'S DEMAND FOR "CONSISTENT INSULATION"

.....closed cellular structure ends "sweat" problem on refrigerant line ...gives it unusual flexibility...plus longer life.

Shown here is the refrigerator evaporator coil of Amana's Freezer Plus Refrigerator. Amana engineering specifies a closed cellular type of insulation in order to avoid the problems encountered with other types of insulation for this application.

Rubatex Closed Cellular Rubber Tubing serves as insulation on aluminum tubing carrying the refrigerant from upper refrigerator compartment to lower freezer compartment in the FPR14 and FPR18 Freezer Plus Refrigerator models.

Rubatex's nitrogen-filled closed cellular structure makes it completely water-proof; gives it excellent weather-aging characteristics and longer life. Extremely light, soft and resilient properties make Rubatex most adaptable as insulation on any cold lines requiring sweating resistance in manufacture or installation of cooling equipment as well as for formed tubing insulation for commercial, industrial and residential cold line piping.

Available in standard inside diameters of $\frac{1}{4}''$ up to and including $2''$ with $\frac{3}{8}''$ and $\frac{1}{2}''$ wall thickness. Other sizes can be made to specification.

Produced in any lengths up to 250 feet. Can be slit for installed piping—and can be purchased in pre-cut lengths.

RUBATEX

CLOSED CELLULAR RUBBER TUBING INSULATION

RUBATEX DIVISION, Dept. P-5
GREAT AMERICAN INDUSTRIES, INC.
Bedford, Virginia

PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

For full details and sample of Rubatex Closed Cellular Rubber Tubing—print your name in space below, attach to your company letterhead and mail to us.

Name _____

Send for Free Sample and full details

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Library of Congress Catalog No. 56-12659

To those learned in the lore of libraries, this simple phrase tells a great deal. It signifies that a book has been received and categorized by the people in Washington.

The volume so designated is "*This is Glass*," a new and completely up-to-date survey of the special glasses and glass products developed by Corning research.

We suspect no usual kind of book club will offer this book as a bonus to its members. But, you can get a copy, free, just by asking us for it.

Here's what the cover looks like.

Why should you want such a book? Because within its 64 pages (sized 8½" x 11" for easy filing) you'll find words, pictures, and tables dealing with glass as a basic material of design and construction.

Sample—pages 12 and 13 tell about the following special types of glasses: Colored, Electrically-Conducting, Multiform, Fiber, Opal, Radiation-Absorbing, Cellular, Radiation-Sensitive, and Optical.

The table on pages 18-19 is devoted to data for 8 *much-in-demand* glasses. It tells of Viscosity Reference Points (working, softening, annealing, and strain); Specific Gravity; Expansion Coefficient; Young's Modulus; Electrical Properties (volume resistivity, dielectric properties); and Refractive Index.

For example, from this table you learn that PYREX brand glass No. 7740, a borosilicate glass, has an expansion coefficient of 32.5 x 10^{-7} per ° C., between 0 and 300° C.

This ability to cope with thermal change, along with immunity to most acids and alkalies, makes 7740 the top choice for diverse applications such as drainlines for waste acids; pipes for corrosive fluids; flasks for coffee (no adding to or taking *from* the taste); heat exchangers; sight glass windows; precision laboratory ware; dental sterilizer trays, humidity chambers—in fact, quite an eye-opening list.

Specifics of this nature are somewhat out of place here, except, we hope as a means of tempting you to expose yourself to the practical and profitable ways in which glass can be used.

"*This is Glass*" is a fine starting point. And it's the type of book that any number of people you know will find both fascinating and useful. Use the coupon.

Heart(h) warming

You're looking at a product that's both warming like a hearth, and heart-warming.

It's Arvin's latest entry in the small, portable put-it-where-you-want electric heater field.

We agree—small electric heaters are not exactly new. But this electric heater uses *glass* as the heating element. That's right, glass—specifically glass by Corning.

These PYREX® radiant heating panels are quite fantastic when you consider that glass normally serves as an excellent *insulator*. But such panels are covered with a permanently bonded, transparent, slightly blue, extremely thin metal oxide coating. It's the coating that carries the dielectric current and puts forth an astoundingly uniform heat.

Permanent and portable heaters are one use to which this glass has been put so far. In other applications it's proven an excellent electrostatic shield.

And turned around with the coating facing a high-heat source it acts as a reflector, bouncing away the unwanted infrared.

As we said—electrically conducting glass can be like a hearth; also heart-warming because here's a material that might just be the answer to some tricky design or engineering problem facing you.

Heavy glass for weighty problems

What can you do with glass that has a density of 6.22, lets you see through, but still is the equal of the same-thickness iron in stopping gamma radiation?

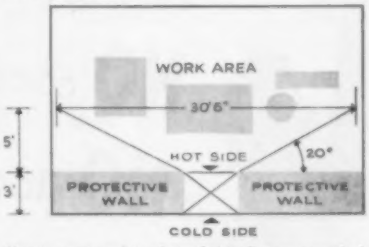
You'll be in good company if you use blocks of this optical-quality glass (along with some other special Corning varieties) to build windows for "hot labs."

These *ponderous peepholes* (that's what LIFE dubbed them) are often constructed with three unusual glasses.

Code 8362 is a nonbrowning lead glass with a density of 3.27 and is practically water-white. 8363 is straw-colored, a really heavy glass, density 6.22. And 8365, weighing in at 2.67 gm./cm.^{3}, is water-white.

In combination (especially as ready-to-install assemblies with oil "baths" between the glass layers) these windows provide protection, plus extremely good visibility.

Glass quality, plus high indices of refraction make for effectively large viewing fields, even with smaller area window on the "cold" side.



Here's a schematic of the field of view provided by a 3-foot thick, standard oil-filled assembly of Corning glass, Code 8362. A number of special glasses by Corning permit visual control plus protection from gamma radiation.

All the facts, including suggestions for radiation shielding window design, are packed into a 12-page Bulletin, PE-51. This recent addition to our literature file is titled "*Corning Radiation Shielding Windows*." One or more copies free with the coupon.

P.S. Glasses for ponderous peepholes are one of many types Corning has developed for special research and industrial problems. If you have a real knotty situation, we may already have a glass answer. Inquire in as much detail as you deem fitting.

Corning means research in Glass

CORNING GLASS WORKS, 51-4 Crystal Street, Corning, N. Y.

Please send me the following material: "This is Glass" ☐; Bulletin B-83, "Properties of Selected Commercial Glasses" ☐; PE-51, "Corning Radiation Shielding Windows" ☐.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

MESSAGE from the "NO" men of Laminated Shim Company

You lose **NO** time when you use LAMINUM SHIMS...

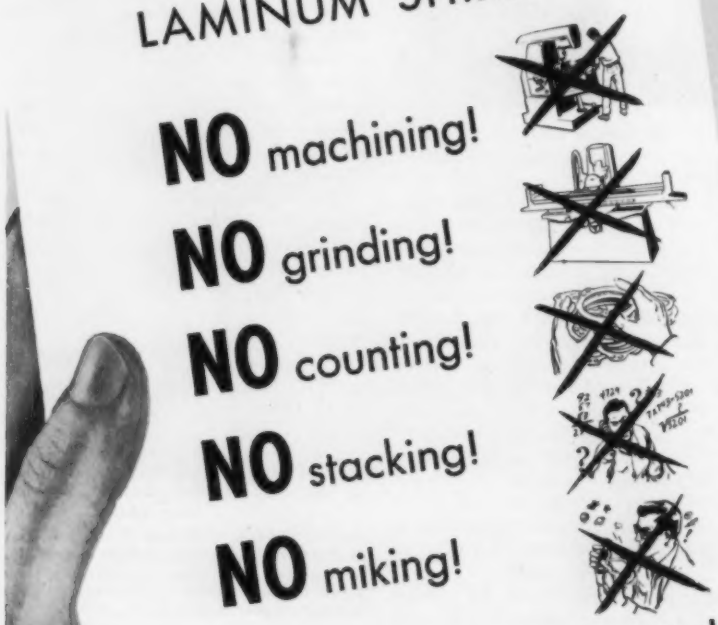
NO machining!

NO grinding!

NO counting!

NO stacking!

NO miking!



...and **NO** dirt between layers—ever!

LAMINUM®

SURFACE BONDED... THEY *peel* FOR ADJUSTMENT

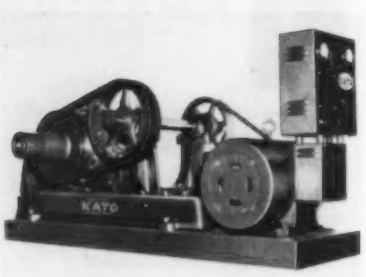
Laminated Shims of **LAMINUM** now available in

STAINLESS STEEL with laminations of .002" or .003"	**ALUMINUM** with laminations of .003" only
BRASS with laminations of .002" or .003"	**LOW CARBON STEEL** with laminations of .002" or .003"

LAMINATED SHIM COMPANY, INC.

Shim Headquarters since 1913

1404 Union Street, Glenbrook, Conn.



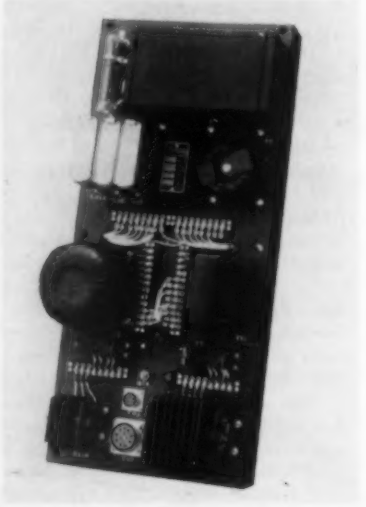
Generator-mounted panel, built to specifications, includes voltmeter, ammeter, rheostat and automatic voltage regulator. Kato Engineering Co., Mankato, Minn.

For more information—
Circle 64, inside back cover

A-c Ammeter

Dial markings on the linear scale are evenly spaced, eliminating crowded divisions at one end. The deflection of the needle is said to be always directly proportional to the amperage. Helipot Corp., Newport Beach, Calif.

For more information—
Circe 65, inside back cover



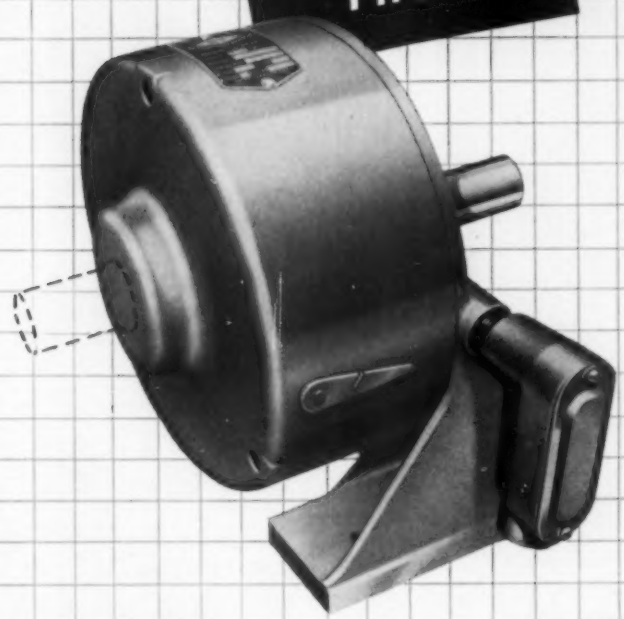
Tubeless Magnetic Amplifiers

Magnetic amplifiers which contain no tubes or moving parts are said to provide instant warm-up. These units may be used in voltage and frequency regulators for a-c or d-c motors and where d-c power supplies are employed.

Consisting of a saturable reactor and rectifier, these amplifiers have ratings

(Continued on page 268)

Another REULAND First!



NEW *REULAND* FOOT-MOUNTED MAGNETIC BRAKE (DISC TYPE) ...COMPLETE with SHAFT and BEARINGS

First and Only Disc-Type Brake to fulfill J. I. C. Specifications The efficient, direct-action operating advantages of the Reuland disc type magnetic brake are now available for the first time in this self-contained unit. Being foot-mounted, it can easily be coupled to existing motor or equipment shafts in accordance with J.I.C. specifications. As a standard unit it also can be purchased "off the shelf" by O.E.M.'s or added to equipment at any time by users. Available with either single or double end shaft.

Also available without shaft Reuland disc type magnetic brakes are also supplied for applications where the motor or equipment shaft can be extended directly into the brake. These units are available in both foot-mounted and endbell mounting types. Together with the completely self-contained unit described above, these brakes provide low cost, compact size and efficient operating features that are unequaled.

Reuland Brakes provide great versatility
Shaft can be extended entirely through brake, when desired. Also, hook-ups with Reuland Fluid-Shaft motors and Motoreducers permit many J.I.C. and other unique power and braking combinations... combinations that can be tailored to your exact drive requirements without huge, special development costs.

Check these added features

- Automatic lining wear adjustment
- Manual release with automatic reset
- Direct action — no levers or linkage
- One-piece, totally enclosed housing
- One-half usual length — pleasing lines

Cutaway view of endbell mounting type

Other Reuland Firsts

1. Motor with internal fluid coupling
2. Spline coupled hydraulic pump motor
3. All-aluminum motor frames
4. "Xpandable" motor design
5. Slip Ring Motors in small #66 frames
6. "Through-Shaft" magnetic disc brakes
7. Precision motors for machine tools

Use these other REULAND SERVICES...

Special-Motor Library
Don't ever pay for special-motor development costs before you check this free library. Contains valuable data on hundreds of unique specially designed motors. Send for free "how to use" booklet.

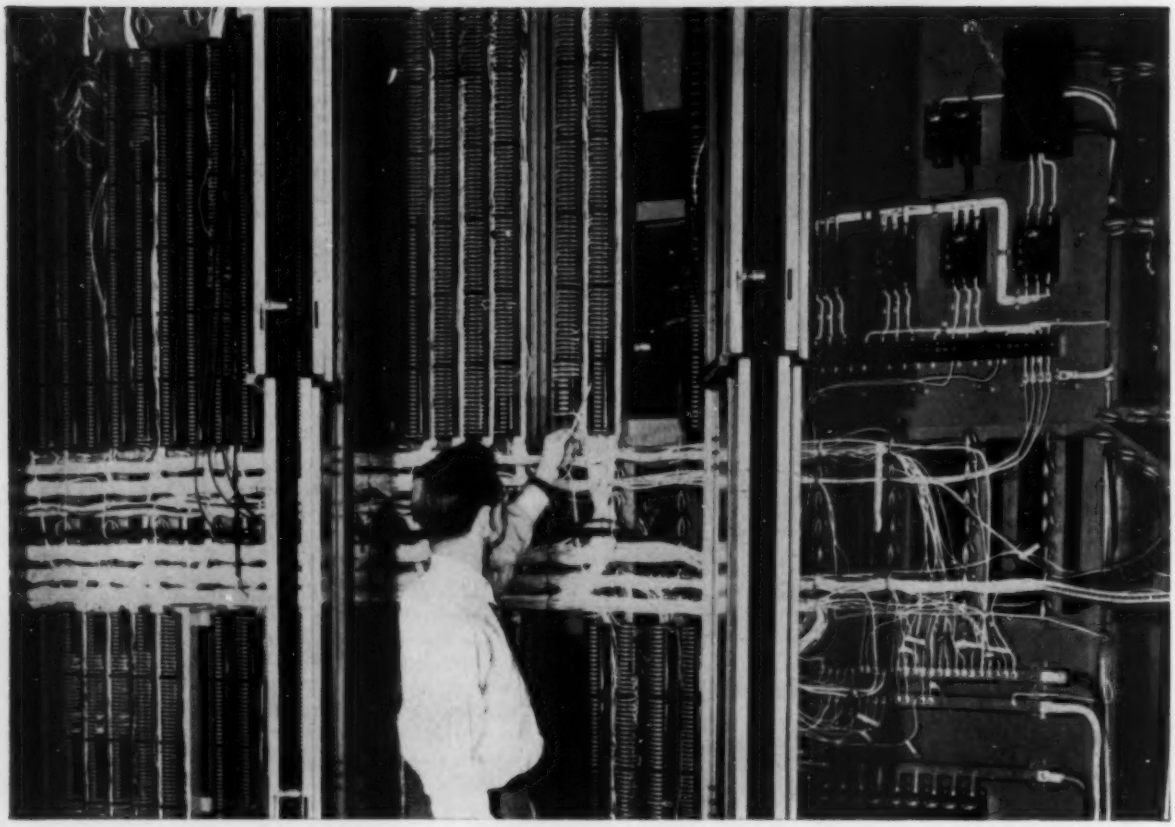
Standard Motor Catalog
Contains engineering information on Reuland's complete line of standard motors and motoreducers. Sent free on request.

REULAND MOTORS

REULAND ELECTRIC COMPANY
Western Division: Alhambra 7B, California
Eastern Division: Howell 7B, Michigan
Distributors in all principal cities

When one of many requirements is

DIELECTRIC STRENGTH



. . . get the others too with **DUREZ PHENOLICS**

Among all materials the phenolics are unmatched for combining dielectric strength with other properties—electrical, thermal, and mechanical—required by many of today's engineered products.

It pays so often to turn first to the Durez phenolics because they are excellent self-insulators, having a high dielectric constant, low water absorption, and good power factor.

Due to their dimensional stability, Durez plastics are specified with confidence by engineers and recommended by molders for close-tolerance components. Impact strength and heat resistance are added major advantages in a wide range of applications.

To help your molder assure the results you want at lowest cost, many types of Durez permit easy preforming and molding in automatic machines. Talk your problem over with him . . . or let us send you engineering data.

At your service is the experience and engineering service that have made Durez the most widely used phenolics.

DUREZ®

Phenolic Plastics that Fit the Job

DUREZ PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

1504 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICALS PLASTICS

THIS ROTARY CAR DUMPER can handle two 90-ton hopper cars simultaneously every four minutes. Main members of the unloader were made of Mayari R high-strength, low-alloy steel to resist fatigue caused by vibration, and to combat the corrosive effects of industrial atmosphere. The high strength of Mayari R, together with its corrosion-resistance, excellent welding properties, superior paint-adherence and other qualities have made it the choice for a wide variety of applications. Our Catalog 353 discusses Mayari R in complete detail.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mayari R...High-Strength, Corrosion-Resisting Steel

BETHLEHEM STEEL

YOUR CYLINDER ORDER SHIPPED IN 24 HOURS OR LESS!

—LET CARTER CARRY YOUR INVENTORY!

ANY BORE SIZE
ANY MOUNT
ANY STROKE

AIR OR HYDRAULIC

CARTER CYLINDERS

Get your cylinders *now*, when you need them. No need to lose production because of poor delivery! Carter will *ship your cylinder order in 24 hours or less*, to satisfy your needs. And when you buy Carter cylinders, you buy quality—rugged, dependable cylinders.

Leakproof construction... strong key-type locking of body between tubing and heads... compact, space-saving design. Everything you need in a cylinder... *plus special delivery to you.* Get in touch with us *today* for what you need *tomorrow!*

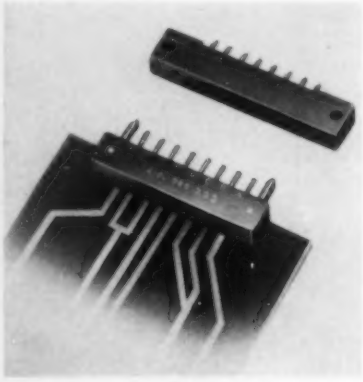
PHONE SERVICE 24 HOURS A DAY!
Order day or night. For fast service call CARTER: LANSING, ILLINOIS, GRanite 4-3305 or CHICAGO, BAyport 1-7186. TELETYPE LNSG, ILL 1119X.

COMPLETE CATALOG FILE!
Complete bound file with ordering details for: Air Cylinders; 750 lb. Hydraulic; 1500 lb. Hydraulic; Clamp Cylinders; Air Valves; Built-in Valve Types. Complete with parts data, specifications and prices. Send today!

CARTER CONTROLS INCORPORATED
2884 Bernice Road • Lansing, Illinois (Chicago Suburb)
AIR CYLINDERS • AIR VALVES • HYDRAULIC CYLINDERS
ROTARY ACTUATORS • SPECIAL CONTROLS

ranging from microwatts to hundreds of watts and power gain up to a million per stage. Electric Machinery and Equipment Div., American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.

For more information—
Circle 66, inside back cover



Right-Angle Printed Circuit Connectors

These miniature right-angle pin and socket plug and socket connectors are made for dip soldering. Series 600-70 has a contact spacing of 0.156 in. This series is available in four and eight-contact units.

Series 676 is available with 19 contacts and contact spacing is 0.150 in. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 67, inside back cover

Pullout Switches

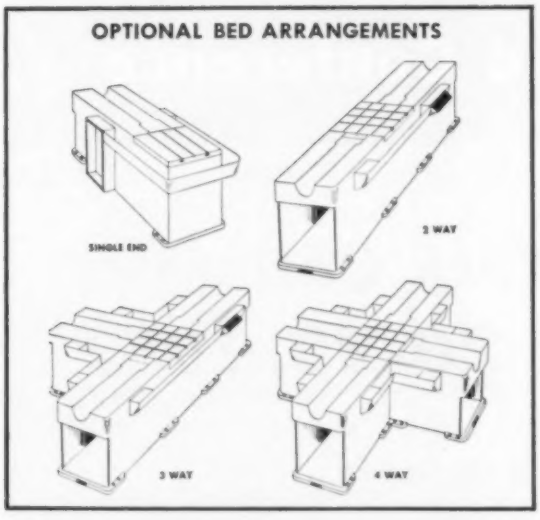
Dead front pullout switches rated at 200 amp have been developed for use in the meter-switch-fuse sequence, for 120/240 v, three-wire, single-phase service, and 240 v, four-wire, three-phase service. The switches have re-

(Continued on page 272)

Photos courtesy of Simplex Machine Tool Corporation, Milwaukee, Wisconsin.

VERSATILITY FOR MACHINE TOOLS

Welded design does it at less cost



These precision boring machines can have one to four boring heads. The beds may vary in length . . . depending on the customers' needs. Such versatility in design and manufacture is made possible with welded steel . . . because:

- **A welded base design can be easily and quickly modified since there are no patterns involved.**
- **Less material is needed since steel is three times stronger than iron, 2½ times as rigid . . . yet costs a third as much per pound.**
- **Less machining, less finishing is needed.**

Basic advantages like these can be applied to many products. A Lincoln engineer who is backed by 45 years of Lincoln cost-cutting experience, will gladly show you how to benefit.

Write for Weldesign Bulletin, available to product designers.

THE LINCOLN ELECTRIC COMPANY

Dept. 1321, Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

When steel is three times stronger than iron **Has** much more versatility **Yet** costs much less

WHY aren't your products designed for welded steel?

Attend the

1957 DESIGN ENGINEERING SHOW

THE ORIGINAL EQUIPMENT MARKET EXPOSITION

and Conference

New York Coliseum
May 20-23, 1957

Here are some of the products you'll see at the show:

Electrical Components
such as actuators, connectors, dynamotors, generators, insulators, meters, motors, switches and relays, rectifiers, solenoids, thermostats, wire and components, thermocouples, strain gages, timing motors, etc.

Mechanical Components
such as axles, bearings, clutches, conveyors, drives, governors, mountings, couplings, speed reducers, timers, wheels, vibration mountings, springs, gears, belts and chains, lubricating equipment, etc.

Engineering Materials (metallic and non-metallic)
such as aluminum alloys, clad metals, beryllium alloys, gray iron, high alloy steels, metal powders, titanium, magnesium, bearing alloys, nickel alloys, etc.; carbon, ceramics, cork, glass, jewels, paper, plastics, silicones, rubber, wood, graphite, etc.

Fasteners
such as adhesives, clips, nuts, retaining rings, rivets, welding, etc.

Finishes and Coatings
such as anodized finishes, chemical colorings, lacquers, paints and varnishes, plated coatings, etc.

Hydraulic and Pneumatic Components
such as accumulators, boosters, controls, pumps, cylinders, hose and tubing, piping, valves, etc.

Shapes and Forms
such as die castings, drop forgings, formed nonmetallics, perforated materials, press forgings, sand castings, tubing, etc.

Accessories
such as computers, drafting instruments; machines, supplies, recorders, reproduction equipment, supersonic generators, transducers, etc.

- Over 350 manufacturers exhibiting on 3 big floors.
- Thousands of products to help you do a better design job and reduce manufacturing costs.
- See for yourself... pick things up... bend them... action is the working atmosphere of this great show.
- Compare one product with another, on-the-spot, to aid your design decisions.
- Talk to technical experts who can read your blueprints.
- Save time at the important job of finding what you need.
- Take home literature and test samples for solving future problems.

Send for these Registration Cards — today!

Make sure you don't miss out on this great design engineering event. Write immediately for your rapid registration cards, requesting as many as you need for yourself and colleagues.

Address your request to:
CLAPP & POLIAK, INC.
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DESIGN ENGINEERING SHOW
341 Madison Avenue
New York 17, New York

invites you to attend the
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New York Coliseum
May 20 to 23, 1957
THE ORIGINAL EQUIPMENT MARKET EXPOSITION
Watch hundreds of product demonstrations. See the widest range of materials, components, parts, fasteners, finishes, in thousands of actual and potential product applications. Talk with the men who engineered these products. Get technical information and literature to help you solve design problems the year around. Find hundreds of ideas for doing a better job of designing new products and re-designing the old. 350 leading manufacturers will present their products to you on three floors of the new, giant New York Coliseum.
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No standing in line if you use this rapid registration card correctly! See instructions reverse side.
SHOW HOURS
12:00 to 6:00 P.M. DAILY
MONDAY THROUGH THURSDAY
CHILDREN NOT ADMITTED

Attend the Design Engineering Conference

Sponsored by the Machine Design Division
American Society of Mechanical Engineers

Concurrent with the show . . . in the New York Coliseum . . . the outstanding Design Engineering Conference will approach design problems from a practical, down-to-earth level. Editors of the four leading design publications will serve as chairmen in sessions devoted to the three major design fields: Mechanical, Materials, and Electrical. We urge you to write for application forms to the Conference.

CLAPP & POLIAK, INC.
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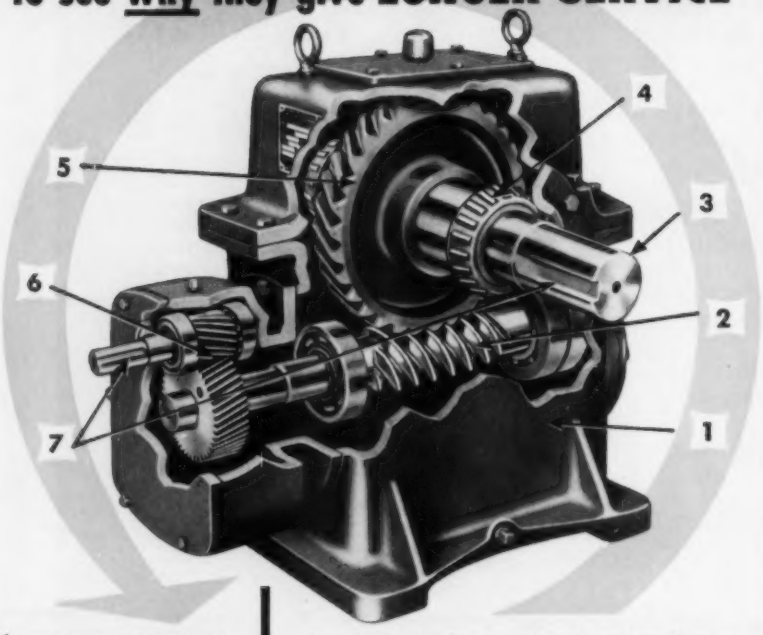
Look Inside a Foote Bros.

ENCLOSED WORM GEAR DRIVE

to see why they give LONGER SERVICE



1 EXTRA STRONG CAST HOUSING
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

2 PRECISION ALLOY STEEL WORM
Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 OVERSIZE OUTPUT SHAFT

4 HEAVY DUTY, EXTRA LARGE BEARINGS
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

5 WORM GEAR
Precision generated from uniform density, high hardness virgin bronze alloy casting. High load carrying capacity.

6 HEAT TREATED HELICAL GEARS
Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

7 Just one of 10 different types, in a wide range of sizes, ratios and shaft arrangements.

One look at the oversize bearings, larger shafts, precision made gearing and the sturdy housing of a Foote Bros. Hygrade Worm Gear Drive tells you that *this* is a workhorse unit that will stand up and deliver under the toughest conditions.

Notice the carefully balanced design . . . greater mass where it's needed . . . the elimination of weight when it contributes nothing to efficiency . . . strength and toughness at the right places . . . the correct gear alloys . . . the compact design, and above all, the simplicity and ruggedness of this unit.

When you know the *inside* story of Foote Bros. Hygrade Worm Gear Drives, you can understand why they have built a reputation for quality, dependability, and performance that is unmatched by others.

Call in a Foote Bros. Field Engineer. Take advantage of our long experience in this business. Let us help you select or specify the most economical drive for your application.

Write for Engineering Manual HGB. It contains complete information on Hygrade Enclosed Worm Gear Drives.

this trademark stands for the finest industrial gearing made

T. M. REG. U. S. PAT OFF

FOOTE BROS.

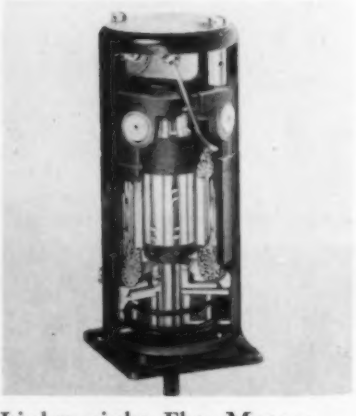
Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4575 South Western Boulevard Chicago 9, Illinois

versible puller heads, a cutaway window in the fuse block to indicate on and off positions, fuse block guide slots, spring-loaded fuse holders and the elimination of hinged joints to reduce heating and maintenance. The device is always dead front, even with puller heads out.

UL-approved for use as service equipment, the units are available in general purpose, flush or surface, and NEMA III (raintight) enclosures, equipped with interchangeable adjustable hubs in sizes ¾ to 2 in. The 200 amp rating is obtained without reduction of wiring space. Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.

For more information—
Circle 68, inside back cover



Lightweight Fhp Motors

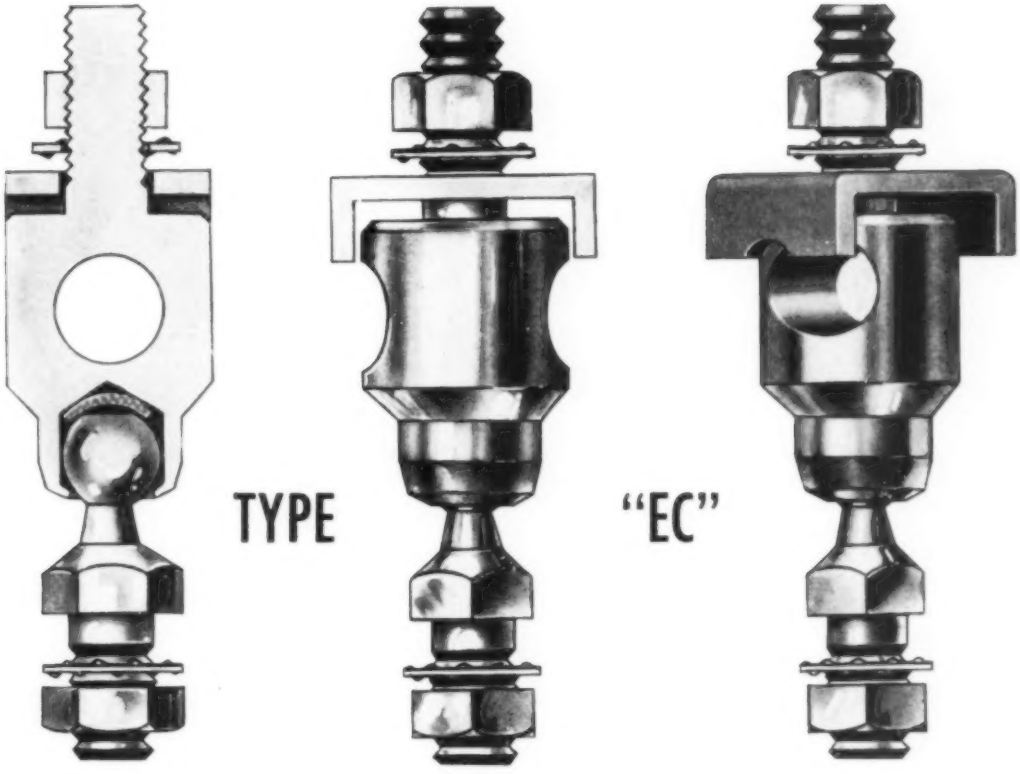
The 26-v motors range from 1/20 to ⅛ hp and weigh 15 to 22.5 oz. An electro-mechanical brake with high holding torque, an integral radio noise filter, a brush rig construction said to provide nearly flat brush pressure characteristics, an adjustable brake gap, and steel inserts in an aluminum housing are provided. The motors are wound for operation in ambient temperatures up to 70 C and are tested to MIL-M-8609 (ASG) specifications. Lundy Mfg. Corp., 36-08 33 St., Long Island City 6, N. Y.

For more information—
Circle 69, inside back cover

Line Voltage Regulator

Designed to meet or exceed MIL-E-4158A, the automatic voltage regulator is for use in military or critical indus-

(Continued on page 275)



Improved Ball Joint Design Gives Added Wall Thickness

The design of this Ball Joint locates the ball socket in the same unit as the cross drilled hole. This provides additional wall thickness. A specially designed Ball Stud with a short neck enables *more than 250 lbs. force* to be applied on this unit. Swivel construction is assembled with a grease resistant neoprene washer to cushion movement and maintain proper tension. A spring clip allows rapid adjustment over great length, eliminating threaded rods and conventional set screws. Nut, lockwasher and spring Clip are permanently assembled on the unit to prevent loss. "EC" Ball Joints are stocked items for rod sizes 1/4" and 5/16". Present usage includes automatic transmission, heating, ventilating and air conditioning control applications. Get complete information and prices. Write today!

Tourek
BALL JOINTS
The Recognized "STANDARD"

MAIL THE COUPON TODAY!

World's largest manufacturer of "STANDARD" Ball Joints. Also makers of Pipe Plugs and quality Screw Machine Products. Range: up to 2⅜" diameter single and multiple spindle machines. Operations include: Threading • Tapping • Milling • Drilling • Grinding • Polishing • Plating • Heat Treating • Silver Soldering.

ESTAB. 1920

J. J. TOUREK MANUFACTURING COMPANY
1901 SOUTH KILBOURN AVENUE, CHICAGO 23, ILLINOIS

Gentlemen:

Please mail to me at once, complete information and prices on TOUREK "STANDARD" Ball Joints.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

THIS IS A COORS HIGH STRENGTH ALUMINA CERAMIC PUMP PLUNGER, 4½" x 30", WITH AN AMCO-BRONZE PUMP-CROSSHEAD ADAPTER

Coors CERAMIC

...how it solves problems of abrasion and corrosion

IN RECIPROCATING PUMP PLUNGERS

Plungers for reciprocating pumps are an example of how design engineers are using Coors High Strength Alumina Ceramic to combat abrasion and corrosion. The applications vary from small chemical proportioners to oil field water flood pumps, operating under many different abrasive and corrosive conditions. For these requirements, Coors makes solid ceramic plungers in a latitude of diameters from ⅛″ to 6″ and in lengths up to 48″.

Because the material retains its high polish, longer pump packing life is assured. Also, in comparison to other ceramics, Coors has good thermal and mechanical shock resistance. Coors High Strength Alumina Ceramic has proved itself an ideal material for abrasive and corrosive applications, because it has a hardness greater than tungsten carbide, and resists all acids except hydrofluoric.

These properties enable pump manufacturers to stock only one material to cover a wide variety of abrasive and corrosive conditions.

MECHANICAL PROPERTIES

PROPERTY	UNIT	COORS Vitrified High Strength Ceramic TYPE AB-2
Tensile Strength	psi	17,000 - 18,000
Compressive Strength	psi	over 200,000
Flexural Strength	psi	42,000 - 45,000
Specific Gravity		3.40
Hardness	Moh's Scale	9
Maximum Working Temperature	°F	2550
Closest Machined Tolerances	inches	0.000020

DESIGN ENGINEERS — Coors High Strength Ceramic materials and Coors production facilities offer many product design possibilities to engineers where dimensional accuracy, corrosion, abrasion, and heat problems are a factor. For design details and complete mechanical properties, please refer to our 12-page catalog in Sweet's Product Design File.

PUMP USERS — Coors High Strength Alumina Ceramic pump plungers may be obtained only from your pump manufacturer—some pump manufacturers stock our solid ceramic plungers.

COORS PORCELAIN COMPANY

Manufacturers of High Strength Alumina Ceramics

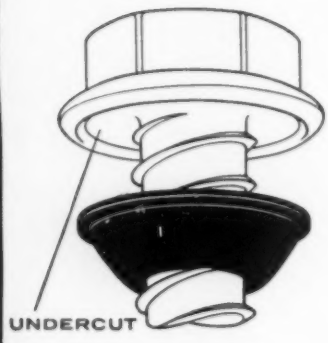
© 1957, Coors Porcelain Co.

Litho USA

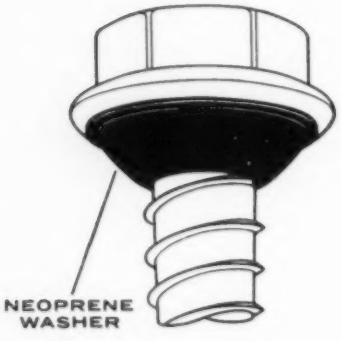
For better products

LEAKPROOF...CUSHIONED TUFF-TITE FASTENERS

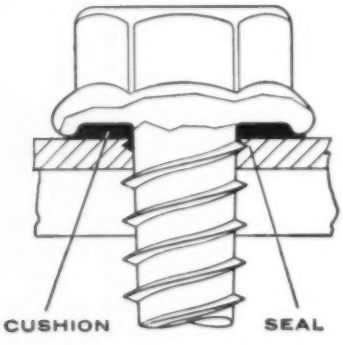
trademark



Undercut of Tuff-Tite fastener head . . .



. . . confines and controls flow of conical neoprene washer



. . . so washer seals the hole and cushions the fastener head!

Now you can • prevent leaks at fastener holes
• protect fine finishes from fastener damage
• stop vibration noises and squeaks

It's the combination of undercut head design and tough, conically shaped neoprene washer that makes Tuff-Tite fasteners work. The undercut helps confine and control spread of the neoprene washer as it is compressed. The washer's conical shape causes it to flow into top threads and seal the fastener hole.

Tuff-Tite fasteners won't mar fine finishes and they stop vibration noises and squeaks because the neoprene washer spreads itself completely between fastener head and surface. The washer actually cushions the fastener and prevents metal-to-metal contact.

Leakproof, non-marring, shock and squeak absorbing! If you need these fastening advantages, you need National Tuff-Tite fasteners. Write for the Tuff-Tite fastener folder describing this line in detail.

THE NATIONAL SCREW & MFG. COMPANY
CLEVELAND 4, OHIO
***Pacific Coast:* National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 22, Cal.

Tuff-Tite fastener facts

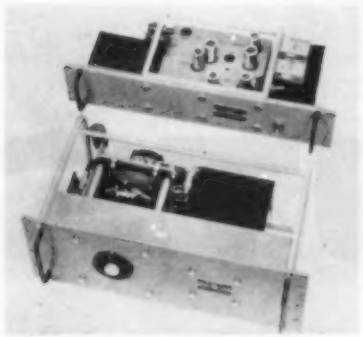
Standard National Tuff-Tite fasteners are available in hexagonal, pan, round and truss head styles for screw diameters No. 6 to $\frac{3}{8}$" inclusive . . . maximum over-all length $1\frac{1}{2}$". Standard fastener types are wood screws, self-tapping screws, thread cutting screws, machine screws and stove bolts. Tuff-Tite fasteners are pre-assembled with neoprene washers.

Washers are molded of neoprene which has a durometer hardness of 85 to 95.

Write for information on *special* Tuff-Tite fasteners.

National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**

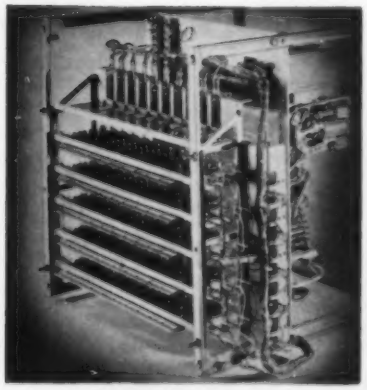


trial applications. Typical applications for which it is suited include those with high ambient temperatures or for portable installations where mechanical shock or vibration is encountered.

The regulator consists of a auto-transformer that adjusts the output voltage, a step-down transformer that effectively multiplies the power rating, and a servo-mechanism that positions the auto-transformer.

The regulator is normally supplied to handle a maximum of 6 kva at 115 v with input line variations of ±10%. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For more information—
Circle 70, inside back cover



Monitor for Up to 200 Data Points

This is a self-contained telemetering instrument capable of scanning, in response to a contact closure, 200 points in sequence, one point per control pulse. The 200 points are arranged in 10 groups of 20 points each. Facilities are provided to automatically skip any group on command, to start at the beginning of any of the ten groups on command, and to auto-

(Continued on page 279)

ideal for wear resistant parts
CHEMISEAL NYLON

COMPLETE SERVICE
- Extruded rods, tubing, special shapes.
- Custom-machined parts.
- Injection Molded parts to specification.

For bearings, gears, cams, bushings, rollers, slides and other mechanical and electro-mechanical parts where wear resistance is essential—and often where no conventional lubricants, or no lubricant at all can be used —*select Chemiseal Nylon (Zytel° 101)*. It is not only the best but the least expensive of the standard Nylon compositions.

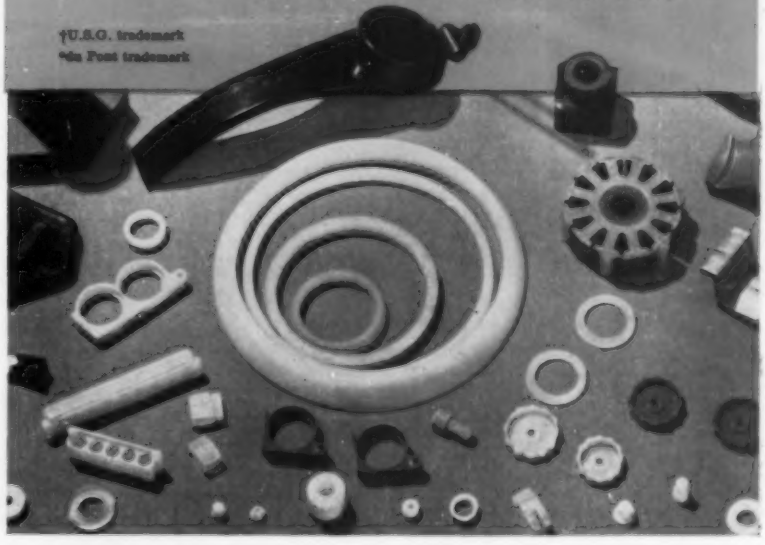
And this superior Nylon is backed by a fabrication service which is more complete than is provided by any other organization. It offers (1) an almost infinite variety of extruded rods, tubing and special shapes for your own production of parts, (2) high-speed, low-cost facilities for custom-machining precision parts to your specifications and (3) large volume injection molding of parts for the ultimate in production economy.

Send detailed dimensional drawings of parts and quantities required, or write for Bulletin N-1056.

United States Gasket Company
Camden 1, New Jersey

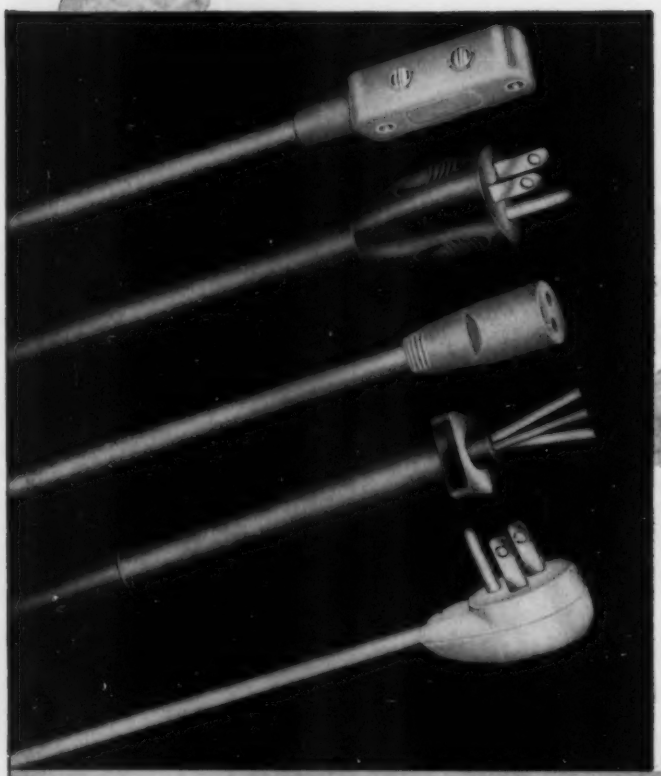
United States Gasket Plastics Division
OF THE GARLOCK PACKING COMPANY

†U.S.G. trademark
°du Pont trademark



just PEANUTS

The difference in cost between "average" cord sets and superlative CORNISH Cord Sets is negligible — just peanuts. The difference in value to your equipment and appliances is very real and considerable. If you want your products to work better, LONGER — play it smart . . .



Cornish 'em...!

All Cord Sets available in **COLOR** to match your appliances, both in Rubber and in Plastic

Send us your specifications; consult us without obligation.

CORNISH

Custom **CORD SETS**

"Made by Engineers for Engineers"

CORNISH WIRE COMPANY, INC.

50 Church Street *Branches in 15 Leading Cities* **New York 7, N. Y.**

Creators and Manufacturers of CORDS AND CORD SETS FOR HOME, FARM AND INDUSTRY

NEW

VICKERS

Miniaturized

PISTON TYPE HYDRAULIC PUMPS

3000 psi . . . CONSTANT DISPLACEMENT

These new miniaturized hydraulic pumps were developed by Vickers for limited life applications such as missile and ram air turbine driven hydraulic systems . . . also for motorpump assemblies supplying emergency power on aircraft.

A distinctive feature is adaptability to manifolding and special mounting. This permits integration with the balance of a "packaged" hydraulic system to provide hydraulic power in the most compact and lightweight form yet devised. Some sizes are capable of delivering more than five horsepower per pound of weight.

Available in four size series, this miniaturized pump has the same basic characteristics as the standard Vickers piston type pump which has been establishing outstanding performance records on aircraft since 1940. Ask nearest Vickers Aircraft Application Engineer for further information.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulics Division

Engineering, Sales and Service Offices:

Adminstrative & Engineering Center
Detroit 32, Michigan

3201 Lomita Blvd.
P.O. Box 2003
Torrance, California

District Sales and Service Offices:
Albertson, Long Island, N. Y., 882 Willis Ave. • Arlington, Texas, P.O. Box 213 • Seattle 4, Washington, 623 8th Ave. South • Washington 5, D.C., 624-7 Wyatt Bldg. •
Additional Services facilities: **Miami Springs, Florida, 641 De Soto Drive**

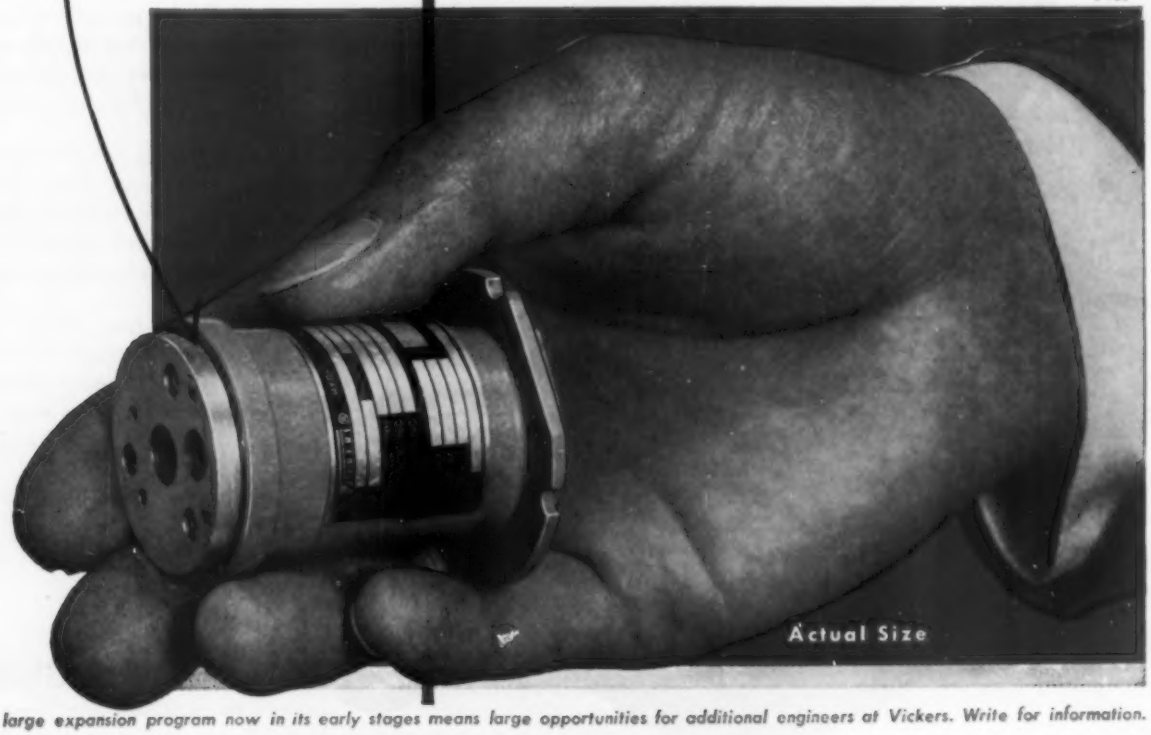
TELEGRAMS: Vickers WUX Detroit • TELETYPE: "ROY" 1149
CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England

Engineers and Builders of Oil Hydraulic Equipment Since 1921

This Hydraulic Pump has 4.3 hp output @ 3000 psi and 12,000 rpm. Weight 0.9 lb.

7469



A large expansion program now in its early stages means large opportunities for additional engineers at Vickers. Write for information.

for smooth power

. . . CONE-DRIVE gearing has no equal.

You can drive the most delicate equipment or the heaviest industrial machinery without vibration or noise through a set of Cone-Drive gears.

Smooth delivery of power is an outstanding feature of Cone-Drive double-enveloping worm gearing. It's the result of a unique design that puts one-eighth of all gear teeth in simultaneous, full-depth contact with the worm threads.

The contact between teeth is "area" rather than the line or point type contact found in cylindrical worm gearing. This distributes the load over more area on each tooth to boost load-carrying capacity.

Want smooth, chatter-free, efficient power in a compact package? Cone-Drive gears will give it to you in gearsets or speed reducers in a wide range of models and sizes.

Ask for Bulletin 600-C for details.

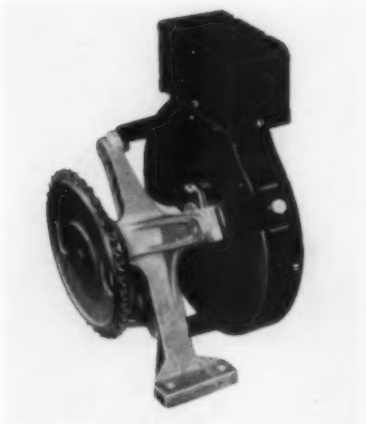
CONE-DRIVE GEARS
Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN

matically stop at the end of any of the ten groups.

The monitor fits a standard 19 in. relay rack and is approximately 14x16 in. deep, including a dust cover. Auxiliary contacts are provided for external control functions, such as printers. James Cunningham Son & Co., Inc., Rochester 8, N. Y.

For more information—
Circle 71, inside back cover



Dancer Roll Rheostats

These rheostats are for multi-motor drives where relative speeds between motors must be maintained within specified limits. A typical rheostat assembly for shelf, floor or ceiling installation includes a single or multi-deck, 6, 8 or 13-in. pressed steel rheostat with stainless steel shaft and a cast aluminum mounting bracket, with or without sprocket and chain. Mounting bracket has ball bearings. Sprockets may be removed or added without disturbing the assembly. Control of single or multiple circuits from a single assembly is permissible.

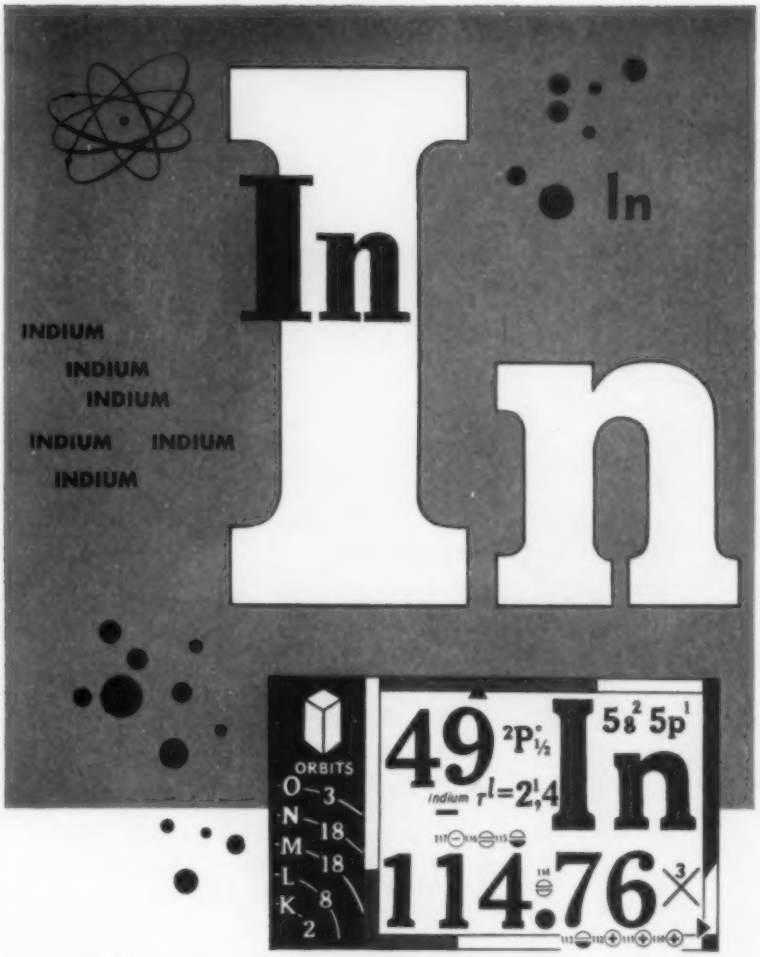
Up to 161 steps of control per plate are possible. Operating torque is ½ to 1½ in-lb per place, average. Ward Leonard Electric Co., Mount Vernon, N. Y.

For more information—
Circle 72, inside back cover

Servomotor Rate Generator

A 115 v, 400 cps, size 18 motor generator, which meets MK 16 MOD 1, weighs 20 oz. It consists of a servomotor and a rate generator contained

(Continued on page 282)



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in revolutionary industrial and engineering advances

QUALITY
at the Indium Corp. of America means: purity of metals, and strict adherence to specifications.

SERVICE
means prompt delivery to customers, and technical help in specific uses of Indium.

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means "forward looking" with respect to new products and new techniques.

Our files contain an imposing list of prominent metallurgists and engineers credited with startling achievements through use of Indium . . . the metal of unlimited possibilities.

INDIUM may have significant applications in your own product development.

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WRITE TODAY

for new Indium Bulletin, "Nomographic Charts of Pellets and Spheres — Weights per Thousand in Grams — with Alloy Analysis Equation."

THE **INDIUM** CORPORATION OF AMERICA
1676 LINCOLN AVENUE UTICA, NEW YORK
Since 1934 . . . Pioneers in the Development and Applications of Indium for Industry.

Next—pilots will watch their own landings on TV!

Up from pitch-dark airfields come light signals invisible to the human eye . . . A new electronic "cat eye" in the cockpit amplifies these signals to produce daylight pictures of the ground on the pilot's television screen.

Thus, in blackout or encased in radiation-proof cockpits, tomorrow's pilots will guide their planes in to safe landings by this latest triumph of electronics.

Like the electronic age itself, the fabulous "cat eye" depends for its operation on the very best of electrical insulations—the kind CDF has been manufacturing for over sixty years.

FOR SPECIFIC INFORMATION on CDF products, see Sweet's, Electronics Buyers' Guide, and other directories. Then send us your print or your problem, and we'll return free samples and technical literature.

CDF MAKES Dilecto Laminated Plastics • Celoron Molded Plastics • Micabond Mica Products • Diamond Vulcanized Fibre • Flexible Tapes of Teflon*, Silicone, and Micabond • Resin-Impregnated Spiral Tubing • *Complete Fabrication Facilities.*

*duPont trademark for its tetrafluoroethylene resin

CONTINENTAL-DIAMOND FIBRE

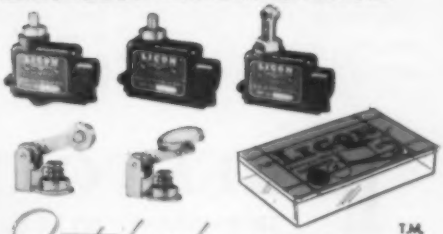
A SUBSIDIARY OF THE BUDD COMPANY • NEWARK 40, DELAWARE

NEW *Switch Versatility!*

LICON® TYPE 30
Enclosed Limit Switch

6 components form 16 switch types!

This is LICON Type 30 . . . the remarkable new switch that offers ruggedness, long life, dependability and versatility in precision limit, safety and interlock switch control. LICON Type 30 limit switches provide adaptability never before possible with so few components—three complete switches, two accessory actuators and optional base mounting plates form sixteen industrial switch modifications. Available with improved sealing feature, or unsealed. LICON Type 30 Switches assure quick replacement in routine maintenance. Write today for complete information on new LICON Type 30 Switchpak. Ask for bulletin No. L-101.



Switchpak (Trade Mark) T.M.

CONTROL COMPONENTS

Three complete switches plus two auxiliary actuators and optional base mounting plates in handy plastic maintenance case. Reduces inventory, permits quick, on-the-job replacement. Save time, save costs, have up to sixteen different switches on hand . . . get Switchpak!

Contents: Sealed Plunger Switch • Overtravel Plunger Switch • Roller Plunger Switch • Lever Actuator • Palm Button Actuator • Three optional base mounting plates

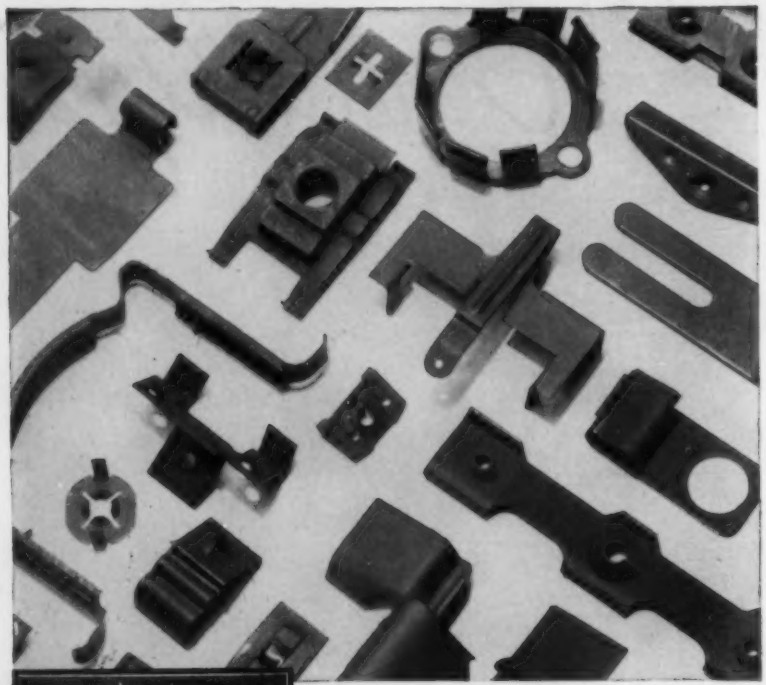
LICON Switches and Controls
DIVISION OF ILLINOIS TOOL WORKS

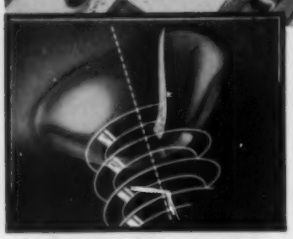
itw

2501 N. Keeler Ave., Chicago 39, Illinois

SPECIALS?

FASTENERS•CLIPS•CLAMPS•FORMS





Creators of the famous Prestole "impression that lasts"—the strongest geometrical shape, with full 360° grip on the screw.

PRESTOLE can solve the fastening problem that is making any assembly operation slow, complicated, and costly, with a Prestole special-type fastener.

When it comes to development, design, and production "know-how" in the fastener industry, Prestole renders an intelligent, specialized engineering service.

Prestole designs and produces special-type fasteners in an endless variety of formed metal parts. Thousands of assembly problems have been solved by this aggressive, experienced organization of fastening engineers.

So, if your assembly problem calls for thread-engaging fasteners or special forms made of various metals—why not let Prestole solve it?

PRESTOLE Corporation

1309 MIAMI STREET • TOLEDO 5, OHIO

PRESTOLE OF CANADA, OAKVILLE, ONTARIO

TELL US MORE ABOUT PRESTOLE DESIGN-ENGINEERING SERVICE FOR SPECIAL/STANDARD FASTENERS.

TO:

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We Manufacture:

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in a housing and rotating on the same shaft. With a rotor inertia of 5.73 g per cc and a minimum torque at stall of 2.35 in-oz, acceleration at stall is 29,000 radian per sec.

Power requirements are: motor fixed phase 9.2 w; control phase 9.6 W; generator 5.4 w. Motor and generator fixed-windings can be wound for any standard carrier voltage supply. Motor control-windings may be custom wound for input from a variety of amplifiers.

The stainless steel housing is 3.68 x 1.75 in. dia. Duty is continuous at stall for ambient temperatures between −55 C and 125 C. Maximum operating temperature is 200 C. Helipot Corp., Newport Beach, Calif.

For more information—
Circle 73, inside back cover

FLUID POWER, CONTROL

Line-Pressure Regulator

The regulator has a built-in pressure relief mechanism that automatically relieves a build-up of back pressure on the delivery side that

(Continued on page 286)

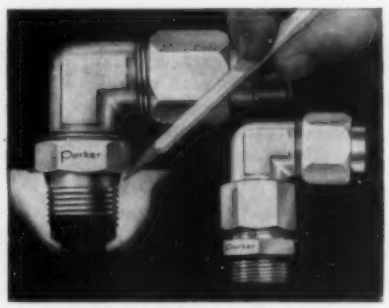
Be sure to see Parker for both tube and hose fittings!

Here, from one convenient source, you can get the most advanced hydraulic fittings available . . . both tube *and* hose. For example, new Parker *no-skive* Hoze-lok fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier to use and *re-usable.*

Also, new Parker *straight-thread* tube fittings solve high-pressure hydraulic leakage problems resulting from tapered pipe threads. *Straight* threads are available on Triple-lok (the industrial standard flare tube fitting) and on Ferulok (flareless fitting for heavy steel tubing).

Parker
Hydraulic and fluid system components

No-skive Hoze-lok fittings need no stripping of hose covers. Only two simple steps complete the make-up. Re-usable.



Straight-thread tube fittings provide leakproof, trouble-free connections. No overtightening. O-ring makes the seal.

TUBE & HOSE FITTINGS DIVISION
Section 422-U
The Parker Appliance Co.
17325 Euclid Ave., Cleveland 12, Ohio

- ☐ Please send *no-skive Hoze-lok* Catalog No. 4433
- ☐ *Triple-lok* Catalog No. 4310
- ☐ *Ferulok* Catalog No. 4320

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Simple bronze plating process gives gold-like finish

- ***M&T copper-tin process deposits extraordinary, golden-glow decorative plate . . .***
- ***Also cuts need for nickel as undercoat***

BRONZE plating has proved itself a practical finish in large and small installations. The copper-tin process developed by Metal & Thermit eliminates usual difficulties and disadvantages in alloy plating. It is as easy to operate and control as normal processes depositing a single metal.

Equally important, this bronze can be deposited with brilliant 24K gold color by using a trouble-free brightener. Protected with a clear organic coating, it provides a high quality decorative finish with unusual appeal and long life. Overall cost of this bronze rivals that of copper and is less than that of a brass plate.

M&T Bronze gets the trophies. Golden-glow finish for die cast trophy cups wins over copper-nickel-gold formerly used by leading producer.

VALUABLE UNDERCOAT

As an undercoat, M&T Bronze has these qualifications: Good corrosion resistance; hardness better than copper and virtually equal to nickel; more ductility than nickel.

Undercoat-bronze can be plated semi-bright or matte. Both buff more readily than copper and with less chance of cut-through on edges.

OPERATIONAL ADVANTAGES

M&T Bronze offers better than twice the speed of fast copper plating solutions. There are numerous installations working at normal current densities of 60-75 amps per sq. ft. Densities of 100 amperes deposit over one-tenth mil a minute smoothly.

Golden-glow bronze delivers uniform color on intricate decorative work. So outstanding is its throwing power, it is being used to replace copper on complex automobile parts. It uses single anode circuits, and copper anodes which corrode uniformly. The tin is supplied by potassium stannate additions, assuring simple, economical control of the process.

For an unusual finish, both in appearance and protective function, the golden-glow M&T Bronze Process offers interesting possibilities to metal finishers and designers. Send for data.

New economy in chromate finishing

Several newly developed Unichrome Dip Compounds work at extreme dilutions. They offer chromate solutions with still lower make-up and operating costs than previously delivered by economical Unichrome Dips. These new Dips make it practical to preserve shelf life and appearance of galvanized, zinc plated or die cast items, even those having low unit price or narrow margin of profit.

MATCHED TO THE NEED

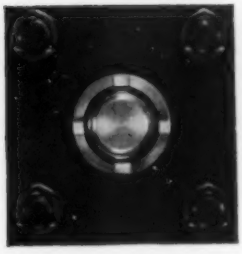
Unichrome Dip Solutions form corrosion-resistant finishes integral with zinc, improve and protect its eye appeal.

But chromate dips are active solutions which strip away zinc as well as convert its surface into an attractive but inactive film. As a result, the type of equipment used and the operating time or cycle affect results. The differing needs of manual or automatic finishing must be satisfied to produce the color, corrosion resistance, uniformity of finish—as well as the economy desired. Since no single chromate solution is equally suitable for all applications, many specialized Unichrome Dip Compounds are made available.

Metal & Thermit will gladly recommend the proper dip to meet specific needs. Simply submit details of product and requirements.

Unichrome is a trademark of Metal & Thermit Corp.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit—United Chromium of Canada, Limited, Rexdale, Ont.



Here are the world's finest power cylinders

...competitively priced!

This ad is written for the man who has thought all cylinders are "pretty much alike." That just isn't so, and your Hannifin man would like an opportunity to show you why...

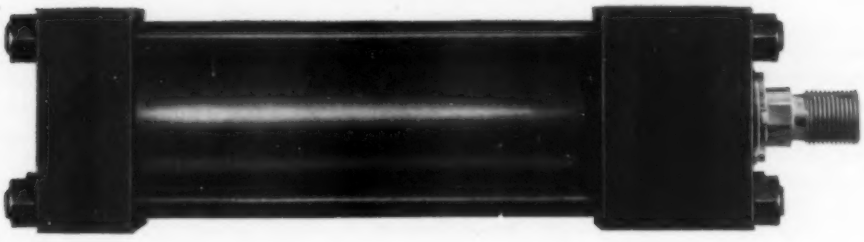
He'll show you design features that other cylinders simply do not have... extra quality workmanship at critical points that pays off in longer life ...accessibility that simplifies their infrequent maintenance. And when he talks price and delivery, you will find these better features cost you no more, can often be delivered sooner.

We think you'll agree that it pays to standardize on Hannifin cylinders.

AIR AND HYDRAULIC

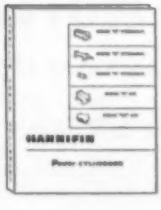
HANNIFIN

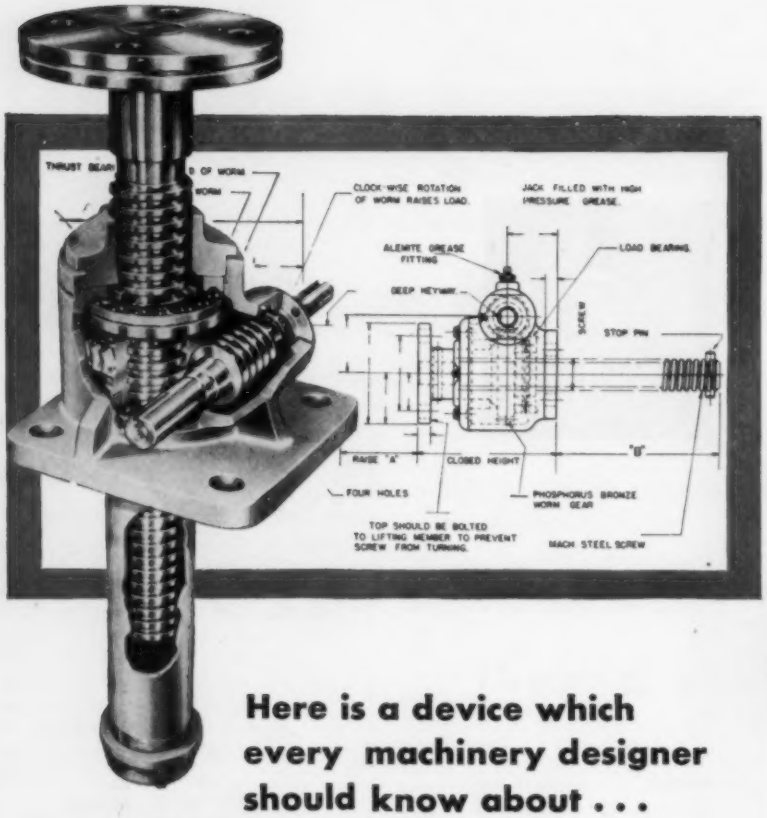
POWER CYLINDERS



COMPLETE CYLINDER FILE

Write for your copy of this new Hannifin Cylinder File . . . complete, easy-to-use, easy-to-order-from information on five lines of Hannifin Cylinders. Write Hannifin Corporation, 525 S. Wolf Road, Des Plaines, Ill.





Here is a device which every machinery designer should know about . . .

DUFF-NORTON WORM GEAR JACKS

Duff-Norton worm gear jacks provide a purely mechanical means for accurate positioning of loads weighing as much as several hundred tons and maintaining them indefinitely without creep. They will operate in any position, and functioning as components of machinery and equipment they can raise and lower loads, apply pressure or resist impact. Jack capacities range from five to 50 tons. When two or more jacks are connected by means of shafting and mitre gear boxes they lift in unison, even when the load is unevenly distributed. They are available with standard raises up to 25 inches, and will provide exactly the same raise for years without adjustment. Worm gear jacks are suitable for operation at ambient temperatures up to 200°F.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, arbor presses, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting bull. AD-34-DD, which includes drawings and full specifications.

DUFF-NORTON

Duff-Norton Jacks

DUFF-NORTON COMPANY

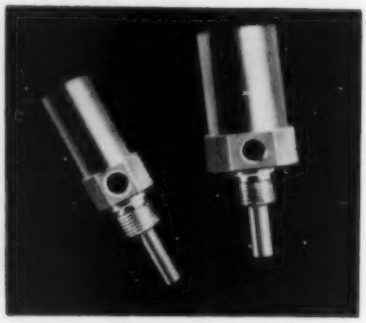
P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION: Danville, Illinois

Rachet Jacks, Screw Jacks, Hydraulic Jacks, Special Worm Gear Jacks, Rachet Hoists, Electric Hoists, Load Binders, Spur Gear Hoists

exceeds the set delivery pressure. The series consists of four styles, delivery pressure ranges of 0 to 40 psi or 0 to 150 psi, and flow rates up to 2500 cu ft per hr. All styles have an O-ring seat that provides absolute shut-off and are offered in a choice of either in-line or angle pattern inlet-to-outlet connections. Hoke, Inc., 197 S. Dean St., Englewood, N. J.

For more information—
Circle 74, inside back cover



Miniature Air Cylinders

These air cylinders, with bores of $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and $1\frac{1}{2}$ in., are designed with $\frac{1}{8}$-in. thick brass tube wall. The blind ends are silver-brazed to the tube, while the front gland piston rod end is internally threaded, allowing for easy repairs when needed. Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio

For more information—
Circle 75, inside back cover

Air Cylinders

These units are available with standard, ball, swivel, threaded or tool blank piston ends. Available in various length strokes, beginning with $\frac{3}{8}$ in. Burklyn Co., 3429 Glendale Blvd., Los Angeles 39, Calif.

For more information—
Circle 76, inside back cover

Thermostatic Steam Traps

Of cast semi-steel, the traps are designed for installation requiring frequent shutdowns and startups, elimination of large amounts of air or maximum protection against freezing. Traps are provided with bronze or Monel bellows and vertical outlets

(Continued on page 290)

RESULT: Better Finish at Lower Cost

In addition to the long recognized advantages of Eaton Permanent Mold Gray Iron Castings, the use of shell coring gives an even greater uniformity of structure and an improvement in internal surface finish. This results in machining economy and fewer rejections, which, in the end, mean lower cost of finished parts.

If you have applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings offer many advantages. Whatever your requirements, our engineers will be happy to work with you.

Send for Illustrated Descriptive Literature

Consider these Important Advantages

- ★ Intricately cored sections
- ★ Uniformity of castings
- ★ Higher machining feeds and speeds
- ★ Substantially increased tool life
- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take high surface finishes
- ★ Freedom from leakage under pressure

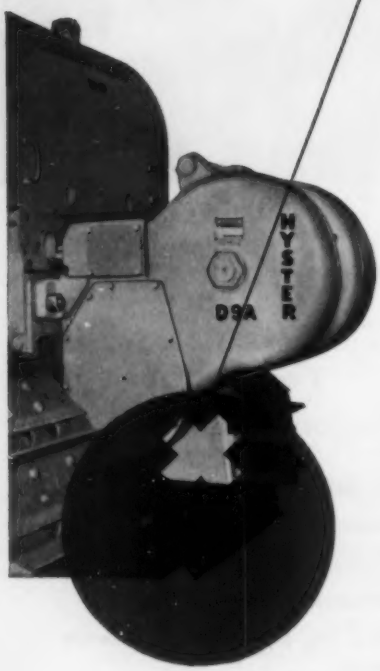
EATON MANUFACTURING COMPANY
FOUNDRY DIVISION
VASSAR, MICHIGAN

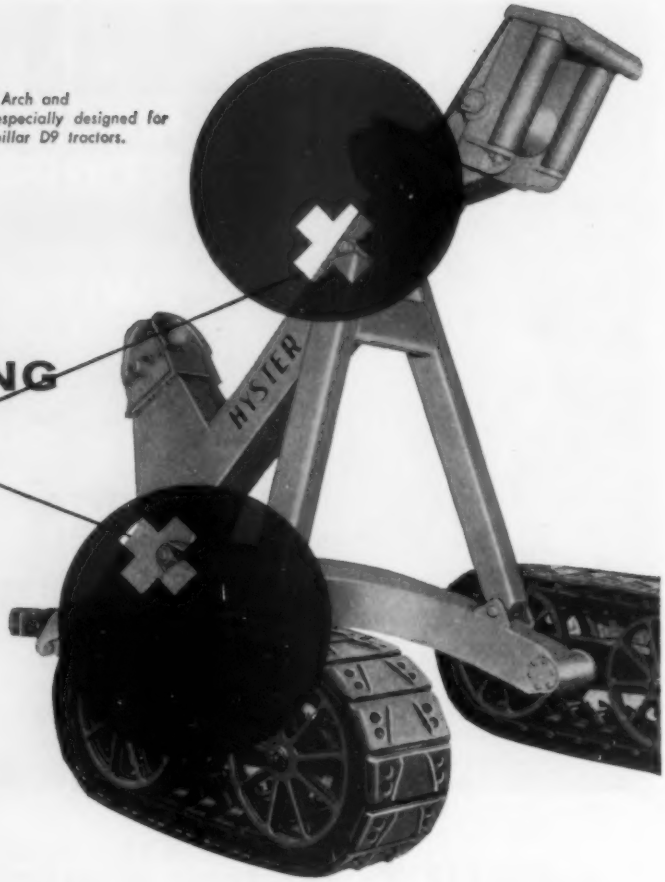
Hyster "98" Logging Arch and D9A Towing Winch especially designed for operation with Caterpillar D9 tractors.

by switching to

OSTUCO TUBING

here and here...





Hyster Company Makes Double-Cut on Costs!

Hyster Company, Portland, Oregon, out to beat machining costs of components in their logging arches and winches and a drawbar bracket, turned the trick by switching from another material to OSTUCO Seamless Steel Tubing.

Drawbar Bracket—Use of OSTUCO Tubing cut material and machining costs from $120,500 to $81,820 annually for a reduction of 32%.

Logging Arch—Used as sleeves in the Hyster "98" Arch, OSTUCO Tubing reduced material and manpower costs 10% annually.

In addition, Hyster engineers report the equipment is stronger and better able to take the strain of heavy hauling and winching jobs over rough logging terrain.

Perhaps you have hidden profit-robbers in your product. Better contact OHIO SEAMLESS for recommendations . . . without obligation on your part, of course.

OSTUCO TUBING

MANUFACTURED IN
SHELBY, OHIO
EXCLUSIVELY BY

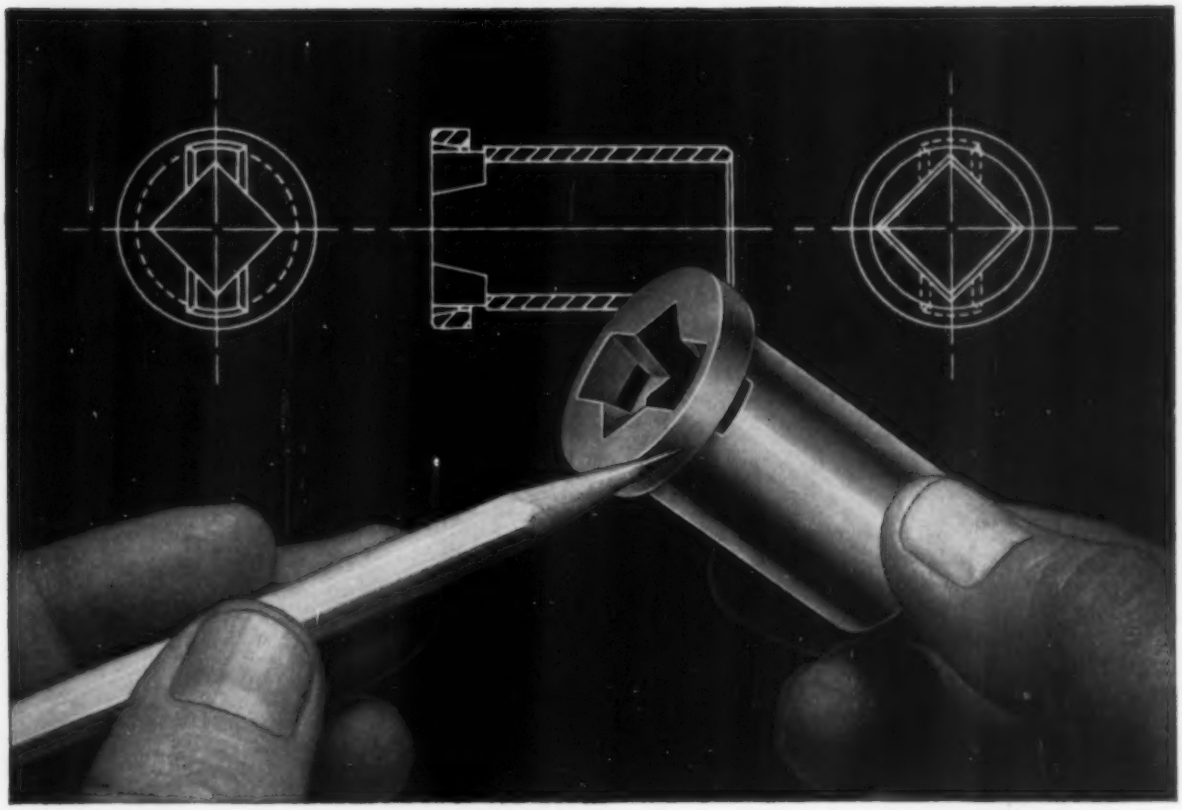
OHIO SEAMLESS TUBE DIVISION
OF COPPERWELD STEEL COMPANY

SHELBY, OHIO • Birthplace of the Seamless Steel Tube Industry in America
SEAMLESS AND ELECTRIC-RESISTANCE WELDED
STEEL TUBING • FABRICATING • FORGING

SALES OFFICES: Birmingham • Charlotte • Chicago (Oak Park) Cleveland • Dayton • Denver • Detroit (Ferndale) • Houston Los Angeles (Beverly Hills) • Moline • New York • North Kansas City • Philadelphia (Wynnewood) • Pittsburgh • Richmond Rochester • St. Louis • St. Paul • St. Petersburg • Salt Lake City Seattle • Tulsa • Wichita

CANADA: Railway & Power Engr. Corp., Ltd.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY, 225 Broadway, New York 7, New York



How Would YOU Produce This Part With No Machining . . . No Scrap Metal?

PARKER SALES ENGINEERS

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Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI 14, Ohio
William H. Broxterman • 2430 Central Parkway

DETROIT 35, Mich.
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GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

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Girard L. Palmer • Belden Hill Road

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Can't be done? Parker did it . . . sharp internal corners, lateral holes, chamfers, flanged end and all . . . by fast, low-cost powdered metal pressing and sintering. No subsequent machining . . . no scrap-metal loss. Just think of the savings compared with conventional machining methods.

In addition to these inherent cost savings, Parker-engineered Powdered Metal Parts offer a wide choice of tensiles, ductility, density, impact resistance and other physicals. Tooling-up is done quickly and at relatively low cost.

It will pay you to check on the economies and design possibilities of Parker-engineered Powdered Metal Parts. Just call the nearest sales engineer listed here or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings POWDERED METAL PARTS

WHY TRY TO SOLVE YOUR GEAR PROBLEMS ALONE?

PERKINS can custom-cut a precision gear to fit your exact needs... make you a gear that guarantees full capacity and trouble-free performance. Many gear-makers promise a precision gear — Perkins delivers precision . . . always. Fifty-two years of gear-making for aircraft, automotive and instrument manufacturers assure top quality. Extensive facilities, modern equipment, rigid production and quality controls produce gears consistently uniform in tolerance with a burr-free micro finish. Perkins quality eliminates production delays and costly rejects for you . . . Perkins gears wear longer, cost you less in the long run. Ask us to quote on your next gear requirement. Then judge for yourself.

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Folder showing custom gears Perkins has made (from various materials) for aircraft, automotive, precision instruments, home appliances, portable and machine tools, and other products. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

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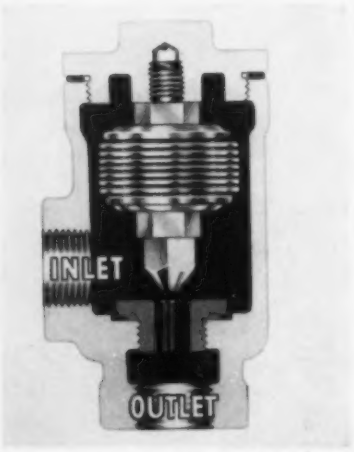
Dept. 32, West Springfield, Mass.
Telephone: REpublic 7-4751



and are fitted with an orifice that operates the entire pressure range from zero to maximum rated pressure. Traps are made for steam pressures up to 250 psi and temperatures up to 450 F. Clark Mfg. Co., 1830 E. 38 St., Cleveland 14, Ohio.

For more information—
Circle 77, inside back cover

Aluminum Alloy Check Valve

This $\frac{1}{2}$ in. check valve is for 3000 psi service. The valves have a rated flow capacity of 1.2 to 29 gpm and a standard ambient temperature range from −65 to 160 F.

Four sizes are manufactured, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$ and 1 in. OD. Three other sizes, $\frac{1}{4}$, $\frac{3}{16}$, and $\frac{3}{8}$ in. OD. are made from steel. These valves are also available in stainless steel. Tactair Valve Div., Aircraft Products Co., 300 Church Rd., Bridgeport, Pa.

For more information—
Circle 78, inside back cover

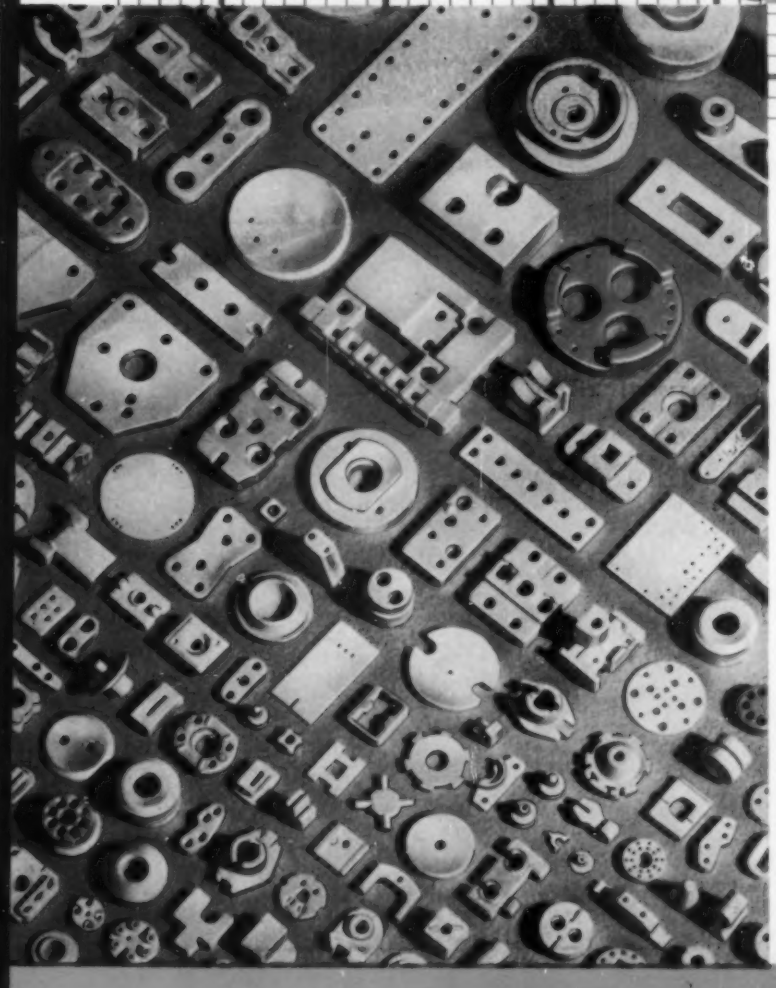
Full-port Solenoid Valve

This cast bronze valve has screwed ends and is available in sizes from $\frac{1}{2}$ to 3 in. with pressure ratings to 300 psi. The valve is single-seated,

(Continued on page 294)

Improves your product. Lowers your costs...

ALSIMAG®
die pressed ceramics



If you need a strong, low cost component . . . custom made for your application . . . with superior electrical characteristics . . . great thermal shock resistance . . . produced to close dimensional tolerances . . . available in volume . . . it will pay you to investigate the "plus" values of AlSiMag pressed ceramics.

Most complete choice of special characteristic materials in the industry, including new and rugged AlSiMag Alumina "super ceramics." Wide latitude in design. Strict Quality Control. Dependable uniformity. Fast deliveries. Batteries of high speed presses. Complete equipment for the most efficient and economical production of parts to specification in any quantity. Ample facilities for volume raw material preparation, firing and machining.

Prototype service available. Check performance under actual operating conditions **before** placing orders for tooling, quantity lots.

Send sketch with detailed specifications for prices and suggestions from our highly specialized Engineering Department on material and design. No obligation.

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AMERICAN LAVA CORPORATION

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55TH YEAR OF CERAMIC LEADERSHIP

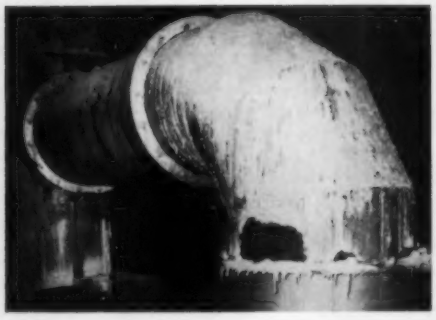
For service, contact Minnesota Mining & Manufacturing Co. Offices in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Calif. • New York: Ridgefield, N. J. • Philadelphia, Pa. • Pittsburgh, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Calif. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ont. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

CYANAMID

PLASTICS NEWSFRONT

THREE YEARS IN CORROSIVE SERVICE WITHOUT MAINTENANCE

That's the record established by reinforced LAMINAC® polyester resin in venting service on alum digesters at Cyanamid's Warners plant. The carbon steel breech (left) in an alum evaporator required frequent maintenance, failed after less than three year's service. Glass-reinforced LAMINAC stacks (right) in even more severe alum digester service, have needed no maintenance in more than three years. The LAMINAC units cost less in the long run, and were easier to erect and assemble, using either telescope joints wrapped and polyester-welded on the site, or flange-type joints.



ATTRACTIVE, AIRTIGHT CASE FOR STICK COLOGNE

Six new scents of Avon Stick Cologne are packaged in smartly styled, practical cases molded of BEETLE® urea molding compound. Cases have a white base with contrasting closures in a different color for each scent. Airtight, the BEETLE case stops evaporation of the cologne. Yet the closure opens easily, and with a twist of the wrist the stick pops up for use. The case resists alcohol, essential oils and chemicals as well as staining from perspiration and grime, which wipe off easily.

FUNCTIONAL HANDLES GRACE CARAFES

Any dining or buffet table would be graced by this attractive carafe with its stylish, beige-colored handle molded of CYMEL* melamine molding compound. Elegance and function are combined in the handle, balanced for easy, comfortable pouring. Harmonizing with the carafe's gold decoration, the molded-in color won't chip or wear off. In keeping with its function, CYMEL is exceptionally strong, resistant to heat and flame, and stays cool even when the carafe, made by Club Aluminum Products Company, is full of hot coffee.

*Trademark

1907 1957

AMERICAN CYANAMID COMPANY
PLASTICS AND RESINS DIVISION
40A Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

Offices in: Boston · Charlotte · Chicago · Cincinnati · Cleveland · Dallas · Detroit
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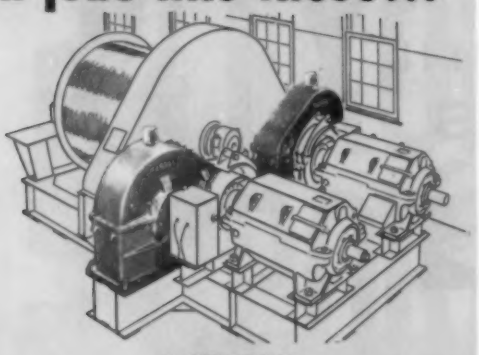
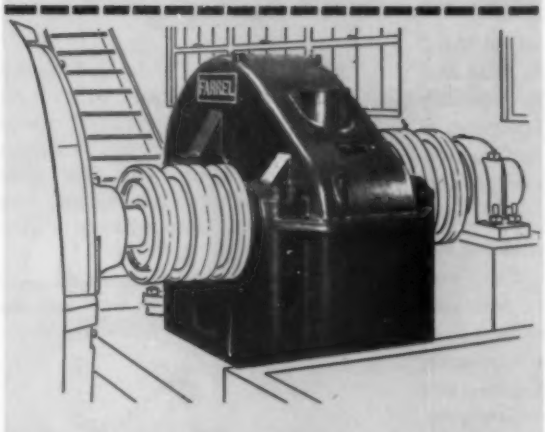
CYANAMID Plastics and Resins Division
MATERIALS FOR TOMORROW

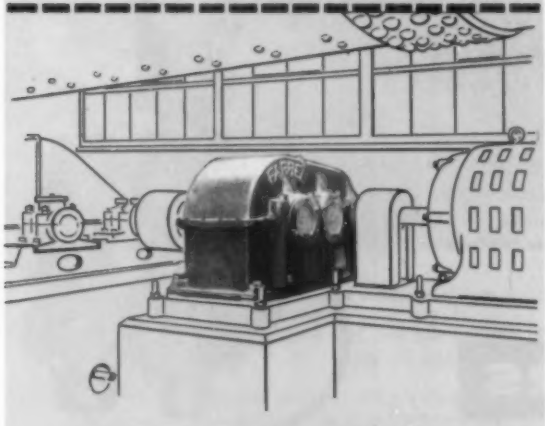
on jobs like these...



. . . A SKIP HOIST



. . . A ROLLING MILL



. . . A ROTARY KILN

Farrel® speed reducers pay off with benefits like these

EXTRA LOAD-CARRYING CAPACITY

The gears in a Farrel speed reducer are continuous tooth herringbone. Instead of a center groove they have a *backbone* where the helices meet. This *backbone* puts the full width of each gear to work transmitting power, providing extra strength and greater load and shock capacity in smaller space . . . perfect for speed reduction jobs.

SUSTAINED EFFICIENCY

When you specify Farrel, you're assured of sustained operating efficiency throughout a long service life, thanks to sound engineering, accuracy of manufacture and use of highest grade materials. Gears are precision-generated; a husky housing maintains operating smoothness of working parts; bearings are antifriction throughout; lubrication is continuous splash for the gears.

BROAD SELECTIVITY

Name the job . . . Farrel has the speed reducer. Both heavy-duty and light-type units are available in a broad range of sizes, and in a series of standard ratios as follows: *Single reduction* — from 1½:1 to 10:1; *double reduction* — from 10:1 to 70:1; *triple reduction* — from 83.9:1 to 323:1. Special designs are obtainable.

These benefits, together with many others, are the result of experience gained in thirty-five years of speed reducer manufacturing. They add up to give you year-round, trouble-free service. Write for free booklet which details the full line of Farrel speed reducers. Ask for Bulletin 450.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y. *Sales Offices:* Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston

Farrel-Birmingham®

FB-1103

NEW!

LOW-COST MIRACLE FABRIC

FELTERS

ALLFAB

Unique, all-purpose non-woven fabric you can put to profitable use

Felters has combined a variety of fibers — wool, rayon, cotton, dynel, nylon and dacron — with a resin (thermoplastic) binder. Result: a felt-like fabric with a tremendous range of fiber combinations — using different diameters, lengths and gravities.

The thermoplastic binder has two big advantages: (1) AllFab will hold any embossed pattern, actually gives dimension to a design; and (2) it is possible to electronic "stitch" or heat seal, eliminating sewing. These features open a new realm of uses as low-cost filler and backing for plastics and upholstery, and for creating new packages and box designs.

Better yet, you name it! Felters will be glad to furnish samples and technical advice to help you save money with this low-cost AllFab.

One of the NEW family of felts . . .

MiraFelt®	MX-101
Dynel-Mat	AllFab
Unisorb®	Cut Felt Parts

Another Fabric First in . . .

FELT by FELTERS

Manufacturers of Felt and Felt Products

SEND for Free Sample and descriptive Bulletin.

FE6-13

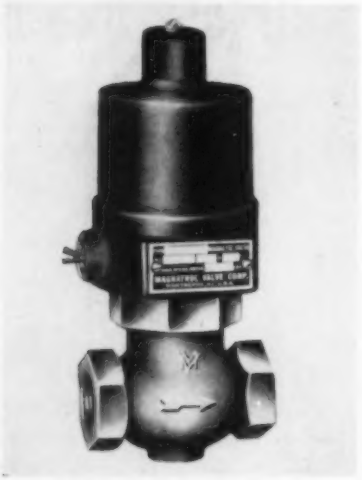
The Felters Co.
228 South St., Boston 11, Mass.

Name.....Title.....

Company.....

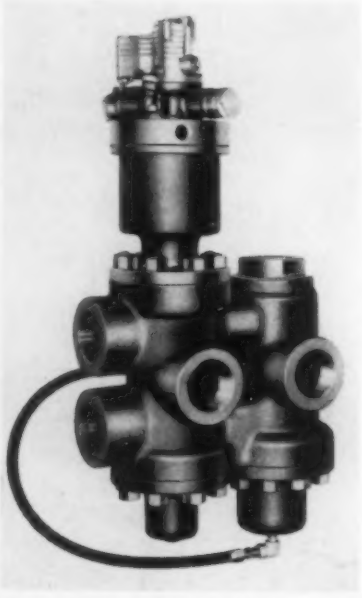
Address.....

City.....Zone....State.....



and is closed by a standard resilient disc. The upper part of the disc holder forms the operating piston, which is controlled by a stainless steel pilot valve. The valve opens when the solenoid is energized. Magnatrol Valve Corp., 73 Fifth Ave., Hawthorne, N. J.

For more information—
Circle 79, inside back cover



Four-Way Hydraulic Valve

A 3000-psi, semi-automatic valve, originally designed for die-casting machinery, handles water, glycol or oil-base hydraulic fluids. Activated by an integral double-acting cylinder controlled by a single or double solenoid,

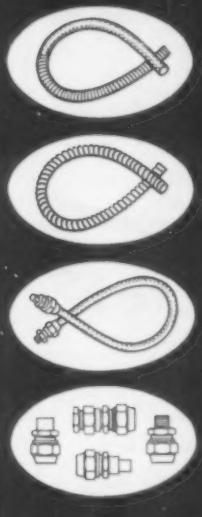
(Continued on page 298)

with the acquisition of FLEX-O-TUBE...

FLEXONICS CORPORATION

now offers the FIRST COMPLETE LINE
of flexible hose products in all materials

FLEXON®
Metal Hose and Fittings



CORRUGATED HOSE

Flexon corrugated hose is the standard of the industry. Available in a variety of types in stainless steel, steel, bronze, alloys.

CONVOLUTED HOSE

Manufactured by Flexonics Corporation for over 35 years, Flexon convoluted hose is made in all commonly used types and materials.

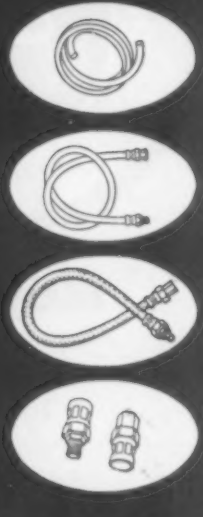
HOSE ASSEMBLIES

A wide range of standard and special hose assemblies are manufactured by Flexonics Corporation to meet industrial requirements.

FITTINGS

A complete selection of couplings and fittings are offered for use with all types of Flexon metal hose for all services.

FLEX-O-TUBE®
Rubber and Synthetic Hose and Fittings



BULK HOSE

Flex-O-Tube bulk hose is offered in a wide range of types and sizes for handling liquids and gases for automotive, aircraft and industrial services.

HOSE ASSEMBLIES

Complete hose assemblies are furnished with a broad choice of standard and special fittings for low, medium and high pressures.

TEFLON HOSE

Teflon hose and hose assemblies are offered for use where chemical and temperature resistance and light weight are required.

FITTINGS

Reusable, pressed on, clamp type, flange type, S.A.E. and special fittings and couplings are manufactured for all services.

Now at your service are the combined know-how and engineering and manufacturing facilities of two leading manufacturers of flexible tubing. For you, it means better service on all your fluid conveying problems.

In joining forces with Flex-O-Tube, Flexonics Corporation now offers combined experience totalling 85 years. The combined field sales and service organizations operate through 15 offices in principal industrial cities with representatives in scores of additional centers and in thirty foreign countries.

Now more than ever before it will pay you to bring your fluid conveying problems to Flexonics Corporation—the one manufacturer who can answer virtually every need.

PLANTS AT
Maywood, Illinois • Inkster, Michigan • Elgin, Illinois • Memphis, Tennessee • Rock Falls, Illinois • Savanna, Illinois • Elizabeth, New Jersey • North Hollywood, California • Brampton, Ontario • Windsor, Ontario

Flexonics *Corporation*
CHICAGO METAL HOSE DIVISION
FLEX-O-TUBE DIVISION

General Offices: 1351 S. Third Ave., Maywood, Ill.
In Canada, Flexonics Corporation of Canada, Limited, Brampton, Ontario
Also Manufacturers of
Expansion Joints • Bellows • Thermostats • Aircraft Assemblies and Components

Simple Arithmetic...

Type 302, Sheet Base Price 50.00 cents per lb.

Type 430, Sheet Base Price - 39.25 cents per lb.

Saving 10.75 cents per lb.

in Stainless SHEET Costs!

Now you can SAVE $215 per ton in base price alone!

Many designers and fabricators who are currently using Type 302 stainless can, in numerous applications, specify Type 430 straight chromium stainless and take advantage of the 10¾ cents per pound difference in base price. Some of our customers are already saving more than $215 per ton using our 430 MicroRold stainless sheet.

The steel industry estimates that 50% of all stainless sheet applications could satisfactorily employ Type 430, the least expensive of all stainless grades, as an economical and practical material. When properly applied, Type 430 has all the desirable qualities of beauty, corrosion resistance, strength, long life and low maintenance that no other material, except stainless, can offer.

We are currently producing our MicroRold Type 430 sheets up to 48" wide in thicknesses .005" to .109" with 2B or 2D finishes; and in thicknesses .010" to .109" in No. 3, 4 and 7 finishes.

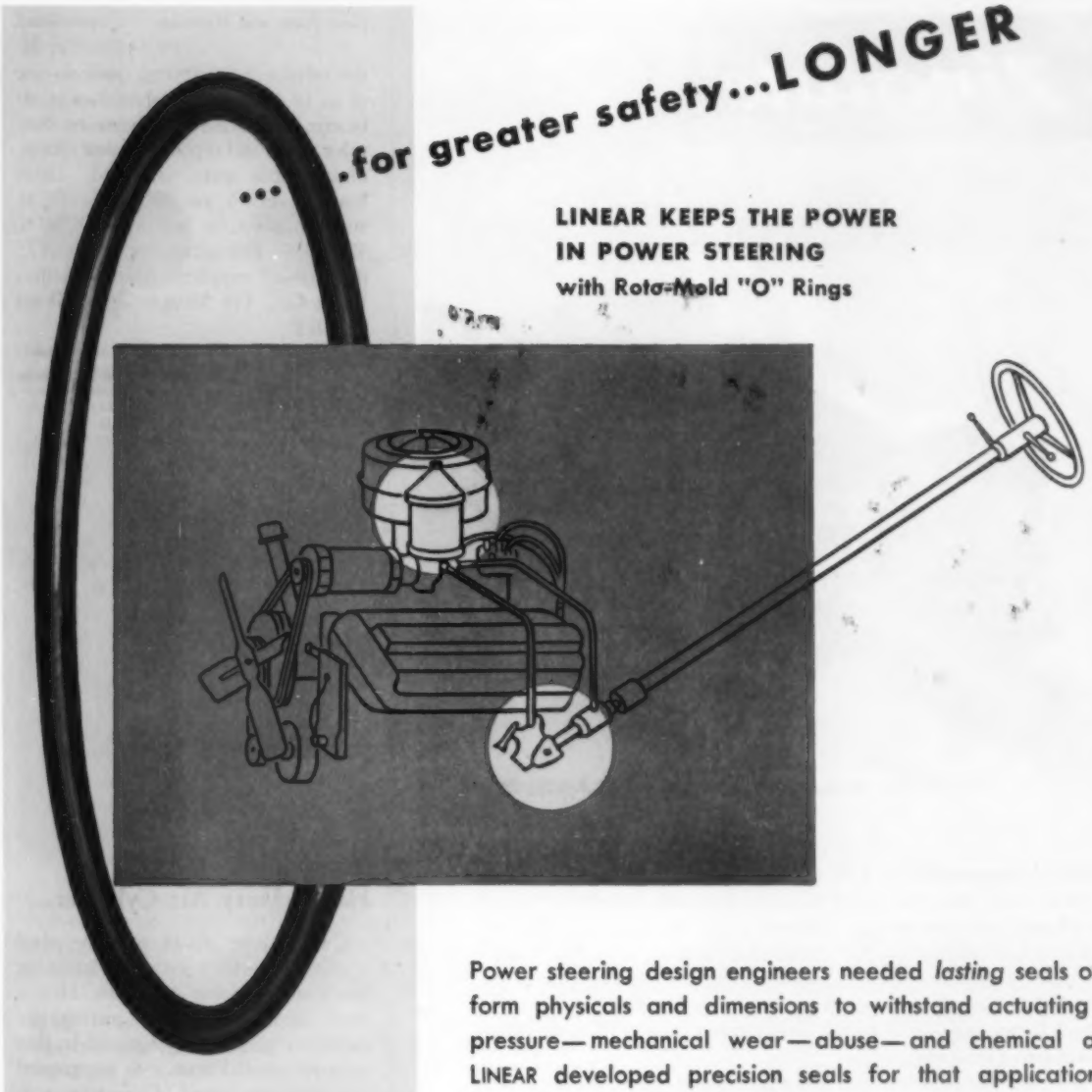
Send for Your copy, "Care and Use of 430 MicroRold Stainless Steel"

Washington Steel *Corporation*

4-G, WOODLAND AVENUE, WASHINGTON, PA.

...for greater safety...LONGER

LINEAR KEEPS THE POWER IN POWER STEERING
with Roto-Mold "O" Rings



Power steering design engineers needed *lasting* seals of uniform physicals and dimensions to withstand actuating fluid pressure—mechanical wear—abuse—and chemical action. LINEAR developed precision seals for that application—to keep the power in power steering.

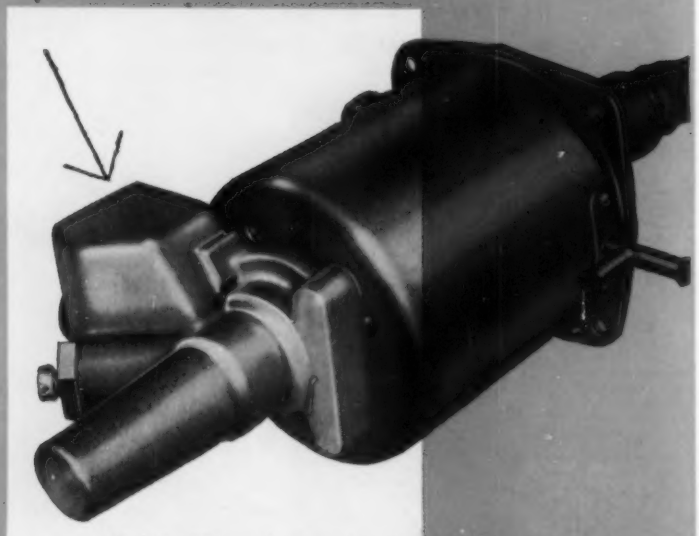
LINEAR'S ability to produce precision "O" rings in the most modern elastomers has helped solve a wide variety of sealing problems involving extreme ranges of temperature, pressure and destructive fluids. The exclusive Roto-Mold process assures top quality production—maximum economy—fast delivery schedules.

When it's a sealing problem, call on LINEAR or one of its agents for engineering assistance—and be sure to specify LINEAR Roto-Mold "O" Rings.

"PERFECTION IN RUBBER"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Zincilate

when ordinary protective coatings won't do!



Zincilate #611 meets all requirements of Spec. MIL-P-26915 (USAF)

In producing power boosters for master brake cylinders, ordinary protective coatings just won't do. If the coating is applied *before* the part is machined and fabricated, it breaks down during processing and there's no more protection. If it's applied *after* processing, then there's the tedious, costly job of masking off the uncoated areas on each piece. Another problem—every power booster must be immersed in diacetone to check for leakage—and the ordinary coating simply disappears upon contact with diacetone.

These are the kind of problems that require an outstanding protective coating—Zincilate. A quick whisk of a spray gun and each power booster is now coated—before machining and fabricating—with Zincilate #611 (one of several Zincilate formulations). There's no time wasted in masking off, and no amount of processing, even including clamping in a vise, will break down Zincilate's lasting, thorough protection. And about that testing for leakage—not even diacetone can pry Zincilate #611 loose!

When results, not mere first cost alone, are paramount, designers and producers of the finest metal products turn to Zincilate for the solution to protective coating problems. If you'd like more information on Zincilate, just outline your problem, on your company letterhead please, and we'll tell you frankly just what Zincilate can do for you.

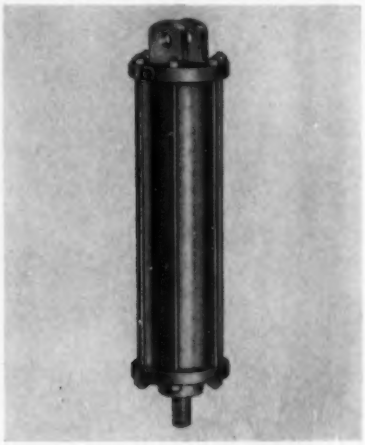
Zincilate

CORROSION-RESISTANT, ABRASION-RESISTANT, WELDABLE, AIR-DRIED and BAKED PROTECTIVE COATINGS

INDUSTRIAL METAL PROTECTIVES, INC., 404 HOMESTEAD AVE., DAYTON 8, OHIO

the valve will not reverse itself in case of air or electrical supply failure. Cast bronze bodies, hardened stainless steel valve stems and replaceable seat sleeve, plus Stellite seats, are used. These four-way valves are offered in 1, 1¼ and 2 in. sizes, for line pressures up to 3000 psi. For actuation, 60 to 125 psi air is required. Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 80, inside back cover



Heavy Duty Air Cylinder

Capsule-type gland of alloy steel is provided in these cylinders. Cylinder heads are cut from steel plate. Heads, steel clevises and steel pistons are cadmium plated. Impregnated leather cups are used. Piston rods are ground and precision honed. Operating pressures are 150 psi on air and 500 psi in hydraulic service.

Available in strokes up to 18 ft, from 3 through 8 in. bore with a wide choice of piston rod sizes. Densmore Engineering Co., Inc., P. O. Box 1557, Oakland 4, California

For more information—
Circle 81, inside back cover

All-position Check Valves

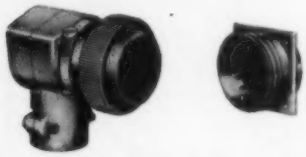
One of these check valves has a rubber poppet, while the other has a flexible metal poppet. The check valve with rubber poppet is said to be noiseless. It operates in any position because a spring closes the poppet automatically.

Pressure rating is 200 psi. The body

(Continued on page 302)

K (STANDARD)

For Aircraft, Electronic, Instrument, Military, Missile, Industrial and Commercial Applications.

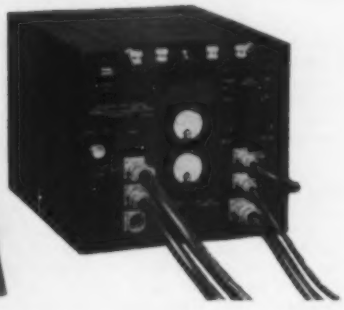


Standard K and RK...in straight and angle 90° plugs, wall mounting receptacles. Conduit and clamp entry types. 1 to 82 contacts in 213 different insert arrangements. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated brass contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 1100 to 5000v 60cps ac rms.

connect with CANNON PLUGS

APPLICATION

Application of R and RK connectors on a recording oscillograph.



original aircraft, electronics, sound, and all-purpose line

KH, RKH
(HERMETICALLY SEALED)

For Use Under Critical Pressure and Leakage Conditions

Hermetically sealed connectors... with steel shells, steel contacts, and Can-seal glass insulators, fused to shell and contacts. *True hermetic sealing.* Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

STEEL SHELL FIREWALL

For Open Flame Protection Against High Temperatures

FW and FWR Cannon K Firewall Connectors... available in straight and angle 90° plugs, wall mounting receptacles. Inserts of phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon made the first firewall connector and continues the leader in this important field.

RECORDER CONNECTOR

For Telephone "Beeper" Connectors

SK-M7-21C...Widely used on two leading makes of telephone recorded connector units known as "beepers" because of the signal required by law in such recordings.

special acme thread • rugged construction • variety of coaxials • integral clamps

RK
PLUG AND RECEPTACLE

For Flush or Semi-Flush Mounting

RK plug and pin assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K series. Note, RK will not mate with K's.

RLKL and LKL
(TV SWITCHING PANEL)

For TV Panel Switching

Quick Connect and Disconnect RLKL Plugs... designed for one-hand fast disconnect use on TV station program switching panels. Feature a quick coupling means. Latchlock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

K ACCESSORIES

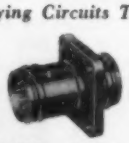
Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, Dummy Receptacles

Featuring High Quality Materials and Workmanship... Junction shells are designed to protect, shield, and carry wires through walls, panels or bulkheads to conduit. Dummy receptacles hold and protect plugs when not in use.

cannon plugs • standard of quality for the industry

TBF-K

For Carrying Circuits Through Bulkheads



TBF-K Bulkhead Connectors... feature a double-faced construction *allowing mating at both ends.* Pin inserts. Single piece shell. Five insert assemblies available.

Other Cannon Series... Mil. Spec. "AN" (full line)—External Power Connectors—Switching Types—dc Solenoids—Guided Missile Launching Connectors—Miniatures and Sub-Miniatures.

See "K" Bulletin for Engineering Data.

Please Refer to this Magazine or to Dept. 106

CANNON ELECTRIC

CANNON PLUGS

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California. Factories in Los Angeles; East Haven, Connecticut; Wakefield, Massachusetts; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities.

ENGINEERING BULLETIN

ON MICRO-BEARINGS

Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: RADIAL AND AXIAL PLAY

This bulletin explains the interrelation between radial play, axial play and contact angle in small instrument type ball bearings, and assists in specifying these characteristics correctly for typical applications.

DEFINITIONS

Radial play is the maximum possible radial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Axial play* is the maximum possible axial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Contact angle* is defined as the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where it makes contact with the raceways under a condition of pure thrust load.

Radial play, axial play and contact angle are geometrically interrelated, but since radial play is the most readily measurable, it is the characteristic usually specified.

In *Fig. 1*, values of axial play resulting from a given radial play and ball size, are given for reference purposes.

SPECIFYING RADIAL PLAY

Two fundamental considerations must be established before arriving at a correct radial play specification: (1) the direction of the load imposed on the bearing, and (2) the axial play control, if necessary for the proper functioning of the unit. This is ultimately a problem of considering the contact angle resulting from a given radial play. High radial play is associated with high contact angle. This relationship is illustrated on *Fig. 2*.

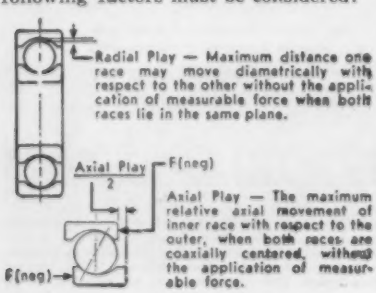
TYPE OF LOAD

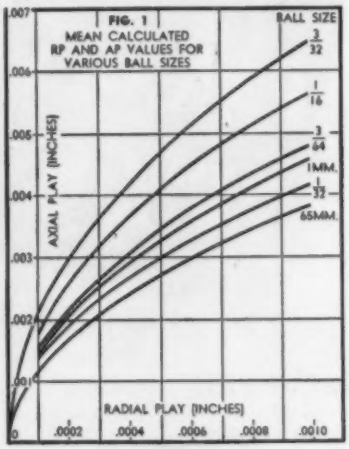
If there is a measurable *axial load*, such as is encountered with bevel gearing, or in an application such as illustrated in *Fig. 3*, the bearings should operate at a high contact angle. Under such circumstances, a radial play of .0005 to .0008 is recommended.

If the application involves a *pure radial load*, such as in the case of spur gears *(Fig. 4)*, there is no concern with contact angle, since it will be zero.

LOW RADIAL PLAY

Functional requirements of the application will dictate whether the radial play is low or standard. However, before *low* radial play is specified, the following factors must be considered:


Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.
Axial Play
F(neg)
Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.
F(neg)



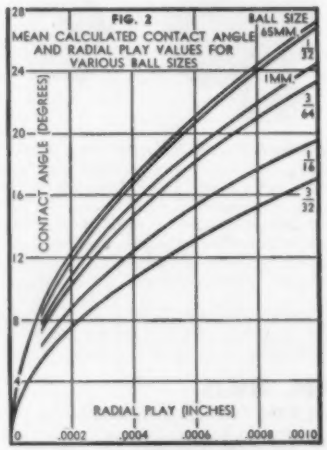


FIG. 5. *Typical Micro-Bearing of the shielded type shown in exploded, cut-away and fully assembled views.*

1. *A bearing with low radial play should not be subjected to interference fitting. This causes reduction in radial play which may create excessive preload resulting in early bearing failure.*
2. *Low radial play results in a low allowable angle of misalignment. An important feature of a ball bearing is its ability to adjust itself internally to possible housing misalignment, particularly when through-boring is not possible.*

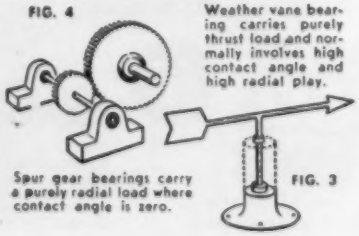
There is one situation, however, where low radial play is recommended. If the bearing is to be subjected to very high repetitious radial shock loads, low radial play minimizes the possibility of bearing damage by distributing the load over a greater number of balls.

AXIAL PLAY CONTROL

If a design calls for axial play values of .002 or less and the bearings are to be used to limit axial travel, it is *not* good practice to achieve this by specifying low radial play. The design should provide for external means of adjustment such as shims. For such cases, the recommended radial play is from .0005 to .0008.

Great care should be exercised if any means other than a calibrated spring is employed to take out *all* axial play. Preloading, with its many complications, may result. Zero axial play automatically yields zero radial play. A high radial play, such as .0005 to .0008, is recommended in cases where axial play is to be reduced to zero by external means.

FIG. 4



Weather vane bearing carries purely thrust load and normally involves high contact angle and high radial play.

Spur gear bearings carry a purely radial load where contact angle is zero.

FIG. 3

RADIAL PLAY SPECIFICATION

There is a misconception among many bearing users that radial play is automatically considered under the ABEC classification. Such is not the case.

However, standard "MICRO" bearings are assembled with a radial play of not less than .0002 nor greater than .0008, unless so ordered. If this range of .0002 to .0008 is acceptable in the application, it is recommended that *No Radial Play Specification* be placed on the bearing.

Radial play is specified most conveniently by a tolerance range. Thus, while the radial play of a given bearing might be .00036, it is more convenient to represent this value as .0002 to .0005. Detailed instructions for specifying other than standard radial play values are incorporated in our catalog.

Since radial play is determined during the bearing manufacturing, specifications of other than standard values should be considered carefully at the design stage, as it may result in delay in assembly and delivery.

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If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in designing instruments or small electro-mechanical assemblies.

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Write: New Hampshire Ball Bearings Inc., Peterborough 1, N. H.

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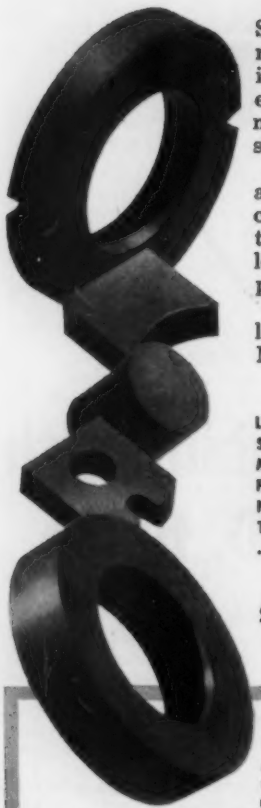

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WRITE FOR CATALOG RC-10A

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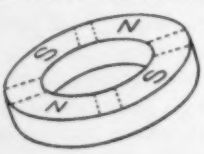

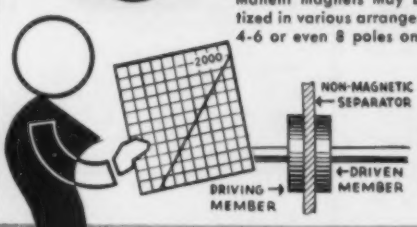

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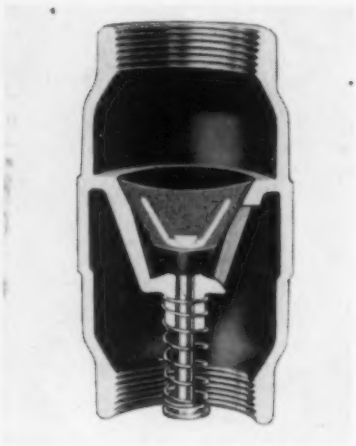

is made of bronze and the poppet is a nickel alloy. These valves are recommended for service in check lines for steam, hot water, cold water, oil, gas and various other compounds. The rubber poppet check valves are available ⅜ to 2 in. Strataflo Products, Inc., Fort Wayne, Ind.

For more information—
Circle 82, inside back cover

Oil Pressure-operated Valve

This hydraulic four-way valve, oil pressure-operated by pilot valve, permits automatic operation when the pilot valve is controlled mechanically. The valve requires oil pilot lines to each end of valve for remote operation from a pilot valve. Ball detents hold valve piston in either end position after pilot pressure has been removed.

Designed for 1500 psi pressure, these valves are offered in seven sizes: ¼, ⅜, ½, ¾, 1, 1¼, 1½ in. Rivett, Inc., Brighton 35, Boston, Mass.

For more information—
Circle 83, inside back cover

Rotary Vane Pump

These positive displacement pumps have capacities of 35 to 275 gph, and pressures up to 300 psi. They are said to be suitable for corrosive liquids, for fluids to 375 F, and for water, fuel oil, hydraulic oil, gasoline, detergents and many chemicals.

The pumps are made of bronze and carbon graphite, stainless steel and carbon graphite, aluminum and carbon graphite. There is a built-in adjust-

(Continued on page 306)

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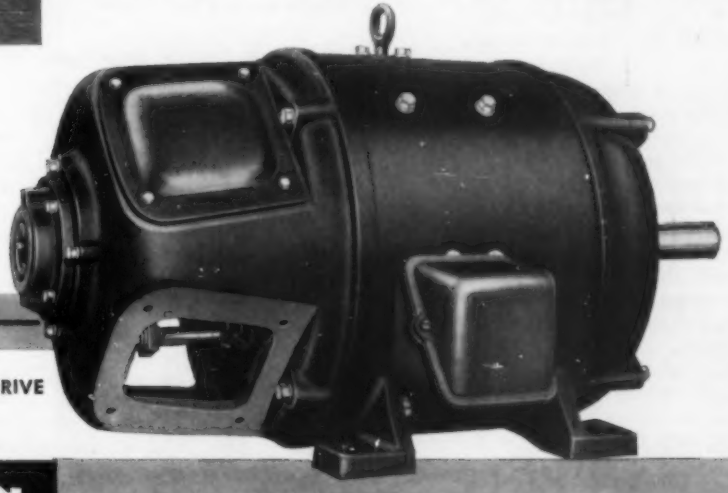

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Cross Wire Welding

How to Use It to Improve Product Design and Quality

What is Cross Wire Welding

Cross wire welding is a method of fastening wires or rods to one another at the point where the wires cross. It is a process that lends itself efficiently and economically to electric resistance welding techniques. In the extremely competitive wire goods field it is essential.

Done in this manner, a cross wire weld is a form of projection welding. The circumferential contour of the wire or rod itself causes the current to be localized at the point where the wires cross, generally at right angles.

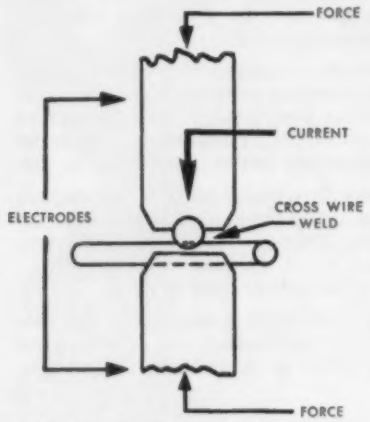

Fig. 1—Cross wire welding process.

The electrode dies which contain the weldable material are connected to a high current, low voltage transformer. Sufficient heat to weld is generated within the parts by the resistance of the metal to the passage of electric current. An electrode pressure forges the heated parts together until the proper amount of weld "set down" has been obtained which gives the piece part its necessary strength.

The term "set down" is the degree to which the wires are pressed together and is measured in terms of percent of wire diameter. It is dependent upon the amounts of heat (current), electrode force, and weld time duration.

STRENGTH OF CROSS WIRE WELDS

(Using Sciaky equipment with suitable settings)

Wire Dia. (in.)	Strength in Pounds					
	Cold Drawn Low Carbon Steel			Hot Drawn Low Carbon Steel		
	15% Setdown	30% Setdown	50% Setdown	15% Setdown	30% Setdown	50% Setdown
1/16	450	500	550	350	400	450
1/8	975	1,125	1,250	750	850	900
1/4	3,700	4,200	4,400	2,800	3,000	3,100
3/8	6,700	8,350	8,800	6,200	6,800	7,200
1/2	12,200	13,600	14,600	11,500	12,400	13,000

Advantages of Cross Wire Welding

Cross wire resistance welding requires no additional metal, arcs, gas or flame. *The weld is within the materials themselves*—and is as strong, if not stronger, than the parent metals.

Fig. 2—Typical cross wire weld section of wire basket.

Appearance is also an important advantage. Cross wire welding is currently being done so efficiently with Sciaky resistance welding techniques that little evidence of the weld is visible in the finished product. The small amount of upset is smooth without splashes or burrs.

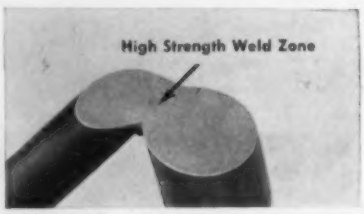

Fig. 3—Diagonal cross section of cross wire weld. Diameter of wires are 5/16" and 3/16"—cold drawn mild steel.

Many products that were not originally designed for resistance welding can easily be adapted with simple tooling. Costly jigs and fixtures can be eliminated too. The capacity of Sciaky patented Three Phase resistance welding equipment permits tooling ingenuity to accomplish a quantity of welds per welder stroke impossible with conventional single phase equipment.

When to Design for Cross Wire Welding

As a rule, this application is done in multiple welds wherever wires or rods must be fastened to each other. Wire mesh, baskets, wire wheel disks are typical examples. A cross wire welding chart has been prepared to indicate obtainable strengths of welds of cold-drawn and hot-drawn low carbon steel of the same diameter.

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Start to build your data file on resistance welding today. Our "Resistance Welding at Work" publication, Vol. 3, No. 9, and Vol. 4, No. 1, contains case histories of Sciaky cross wire resistance welding techniques. Designers' Guide Bulletin 331 discusses other forms of resistance welding.

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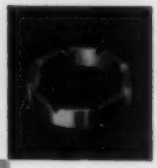

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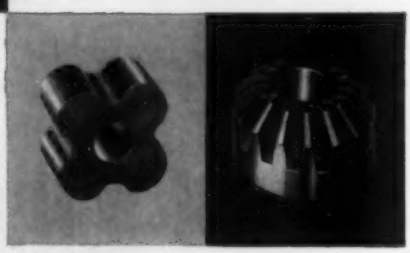

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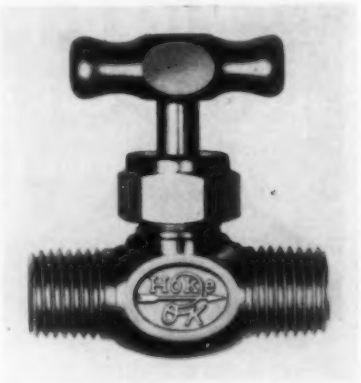
able relief valve. Procon Pump & Engineering Co., 12721 Capital Ave., Oak Park 37, Mich.

For more information— Circle 84, inside back cover



Forged Brass Needle Valves

Small, forged brass needle valves, both angle and straight pattern, have been designed for instrument air lines, test panels, pilot plant installations and graphic panel boards.

The O-ring stem seal is said to eliminate packing leaks and adjustments. Bodies will withstand 2000 psi. There is a choice of male or female pipe thread, or tube ends. Hoke, Inc., 197 S. Dean St., Englewood, N. J.

For more information— Circle 85, inside back cover

Pneumatic Manifold Valves

Two models of manifold valves for pneumatic installations provide air-tight action without the necessity for turning and tightening handwheels. The valves are suggested for pneumatic instrument and control installations and other pneumatic systems.

Model 1583 consists of a two-position piston sliding in a two-port cylinder, and is normally closed. The valve is moved to open position by insert-

(Continued on page 309)

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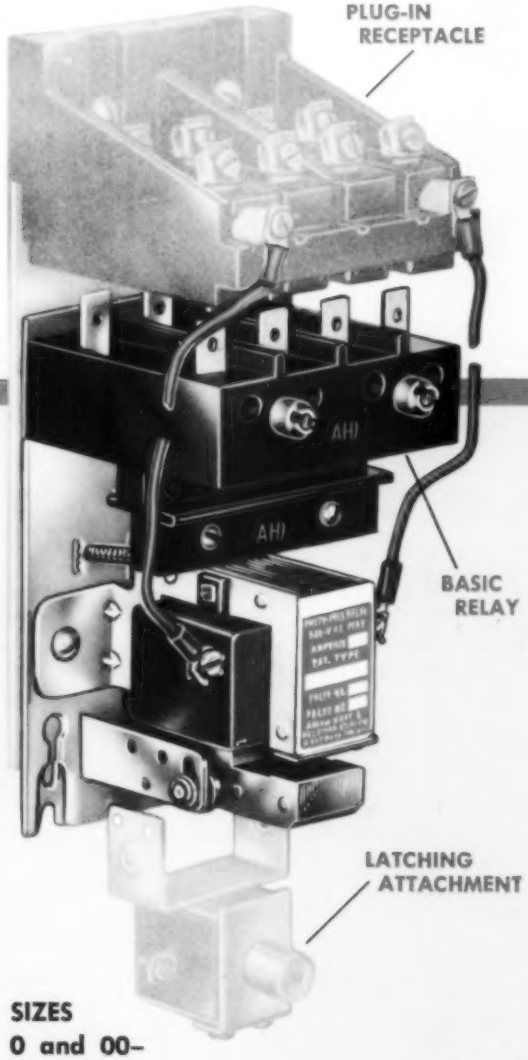

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- **ALL CURRENT-CARRYING PARTS SILVER PLATED** . . . for highest capacity and minimum heating.
- **FRICTION-FREE, DUST-RESISTANT OPERATING MECHANISM** . . . with positive, fail-safe action.
- **ABSOLUTE ALIGNMENT OF PLUG-IN PRONGS** . . . insured by combined receptacle and mounting plate.
- **CONTACTS and GUIDING FRAMES** . . . of special heat-tempered materials to minimize wear and assure smooth action.
- **HIGH-EFFICIENCY SOLENOID MAGNET and MOLDED, LOW-WATTAGE COILS.**

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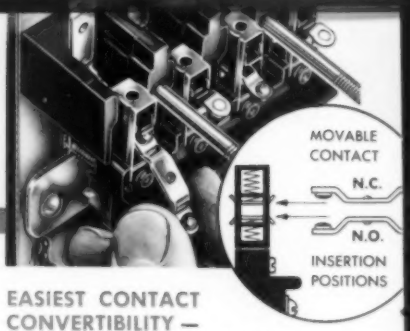
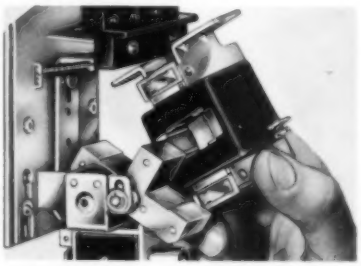


EASIEST CONTACT CONVERTIBILITY —
No tools needed — No loose parts to get lost.



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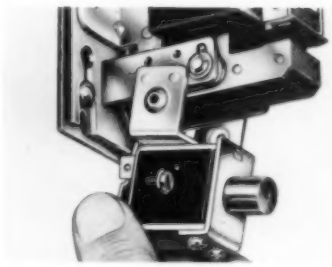
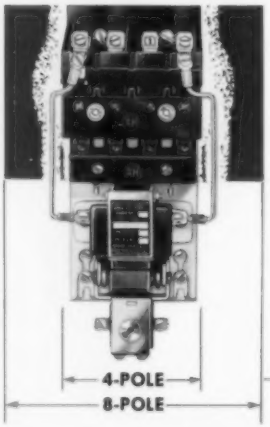


HANDIEST LATCHING ATTACHMENT —
Quickly converts any of these contactors to latching type — attachment simply converted in the field *— latch-in, latch-out, or latched both ways as desired.*



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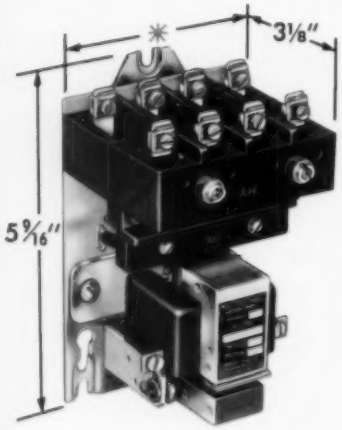
COMPARATIVE WIDTHS

4-POLE and 8-POLE RELAY with OPTIONAL PLUG-IN RECEPTACLE and LATCHING ATTACHMENT



* SEE TABLE

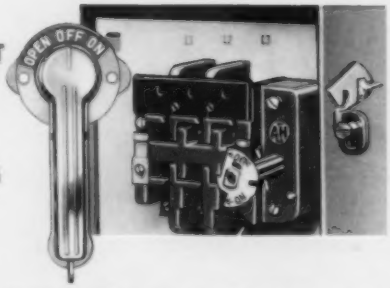
INTERCHANGEABLE MULTI-POLE RELAYS

No Other Relay Offers This Versatility In 2, 3, 4, 6 and 8 Poles	Size 00 10 Amp	Size 0 15 Amp	Applicable in Field	Applicable to Standard Relay
Relay—Type IMP CONVERTIBLE and RENEWABLE Contacts	X	X		
Relay—Type FMP FIXED and RENEWABLE Contacts	X	X		
Optional Plug-In Receptacle	One for both		X	X
Optional Latching Attachment	One for both		X	X

No. of Poles	2 to 4	6	8
Width	3"	4½"	6"

Receptacle adds 2¼" to height and ½" to depth. Latch adds 1¼" to height.

ARROW-HART TYPE "RAD" DOOR DISCONNECTS MEET JIC STANDARDS



the ultimate in —

SAFETY — ALWAYS-VISIBLE CONTACTS give operator constant visual assurance of safety. EASY-TO-SEE HANDLE INDICATORS clearly show "On", "Off", and "Open" positions. SAFE "OFF" FEATURE prevents opening door until handle is purposely turned to "Open" position. LINE COVER prevents accidental contact with live wires.

MINIMUM MAINTENANCE — RUGGED, BUTT-TYPE SILVER CADMIUM OXIDE CONTACTS provide highest possible weld resistance. CONTACTS EASILY REPLACEABLE without disturbing wiring. DISCONNECT HANDLE is oiltight.

EASY INSTALLATION — Both 30 and 60 amp sizes have identical mounting dimensions, making standardization easy. Mounting requires only 3 small holes and 2 screws. Easy-locating feature for hole location. Three adjustable operating shafts take care of variations in panel depth.

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Connecticut
MOTOR CONTROL DIVISION

Please send me complete engineering data on:

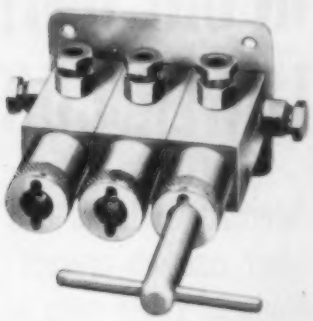
☐ A-H Type "IMP" and "FMP" Contactors
☐ A-H Type "RAD" Door Disconnects

NAME _____
POSITION _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE _____ STATE _____

ARROW AH HART

Quality since 1890

WIRING DEVICES • MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES



ing and turning a key one-quarter turn. When the key is withdrawn, the valve closes automatically under spring tension. The key is attached to the valve by a chain.

Model 1563 consists of two mechanically linked, two-port, two-position piston-type valves normally held closed by spring tension. When a key is inserted and given a one-quarter turn, both valves are simultaneously moved to the open position. Valves close automatically upon withdrawal of the key. Petrometer Corp., 43-22 10 St., Long Island City, N. Y.

For more information—
Circle 86, inside back cover

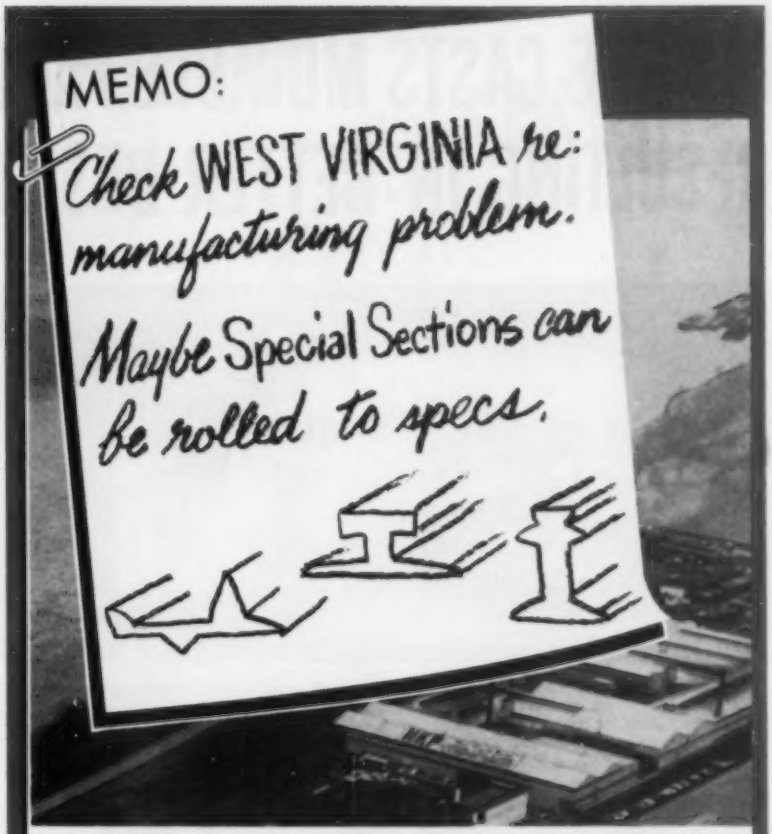
Hermetically Sealed Sight Glass

This sight glass, originally developed for refrigeration systems, is made from a one-piece forging. There are no joints, soldered parts, springs, gaskets or fittings. Into the two ports is fused heat-resistant, high-strength glass.

The word "full" is clearly visible only if the line is completely full of liquid.

The one-piece body design includes wrench flats. The sight glass is said to have been successfully tested at pressures of more than 3,000 psi.

(Continued on page 312)



Investigate **WEST VIRGINIA Special Sections**

Many leading firms have discovered that West Virginia engineers often can solve their manufacturing problems by designing Special Sections to their specifications and tolerances.

West Virginia Special Sections assure ultimate strength and great savings in operating time and costs.

Fifty years of experience in serving industry is yours for the asking. Call or write for free West Virginia Engineering Consultant Service, Connors Steel Division, H. K. Porter Company, Huntington, West Virginia.

50 YEARS OF SERVICE

HKP CONNORS STEEL DIVISION
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GRC DIE CASTS MOVABLE PARTS IN ONE UNIT, RESULTING IN BETTER DESIGN, LOWER COST

This GRC "Intercast" swivel ring on left cast-this assembled complete in single operation. Ring on right required assembly of two screw machine parts plus a metal stamping.

Intercast, exclusive GRC cast-assembly process produces single units or continuously interlocked assemblies, ready for use.

Previously, Metalcraft Corp., leading manufacturer of picture frames needed *two screw machine parts, a metal stamping plus two assembly operations* to complete their picture frame swivel rings. With Gries "Intercast" production, *a single automatic operation casts the unit completely* assembled, trimmed, *and ready for use.* Metalcraft eliminated assembly entirely, *effected economies of over 50%* and received a more attractive component.

"Intercast" is only one of the exclusive Gries die casting techniques and processes that offer industry drastic reductions in production costs and new opportunities for improved design. Unique GRC machines turn out simple or intricate small parts, complete, in one high-speed automatic operation. Many manufacturers have found that Gries facilities give them a better product while reducing costs and eliminating machining and assembly operations.

Gries small zinc alloy die cast parts are made to fit size, shape and tolerance specifications *precisely.* Smallness is unlimited (maximum weight ½ ounce, maximum length 1¼ inches). All are mass-produced at low cost in quantities of 100,000 to many millions.

Send for further information on "Intercast" and other Gries small-parts production facilities, and find out how they can be applied to your particular problems.

Wide Variety of Stock Parts Available from Gries

Zinc-alloy and plastic molded products and components covering hundreds of industries can be obtained from GRC. Industrial fasteners such as wing nuts and cap nuts, are produced in great volume, along with saddlery, awning, drapery and window hardware items, nylon coil bobbins, washers and valve seats; die-cast gears and pinions in hundreds of standard combinations. Many other specific parts available; write for full information today.

GRC Gives Help on Design and Production Problems

To learn how designs can be simplified and assembly operations reduced or eliminated, write for useful reference copy of Gries' fact-filled bulletin. In addition, Gries' staff is available to manufacturers for personal consultation on design and production of GRC automatically die-cast and plastic-molded small parts.

GRC Offers Extensive Facilities

In the modern Gries plant, complete production facilities for small precision parts, plus a highly qualified engineering staff, guarantee the manufacture of even the tiniest, most intricate components to exact specifications. In addition to complete production tooling and design development, comprehensive facilities are available for secondary operations . . . machining, tapping, threading, assembly, etc. Practically all commercial finishes can be applied in the complete Gries plating department.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

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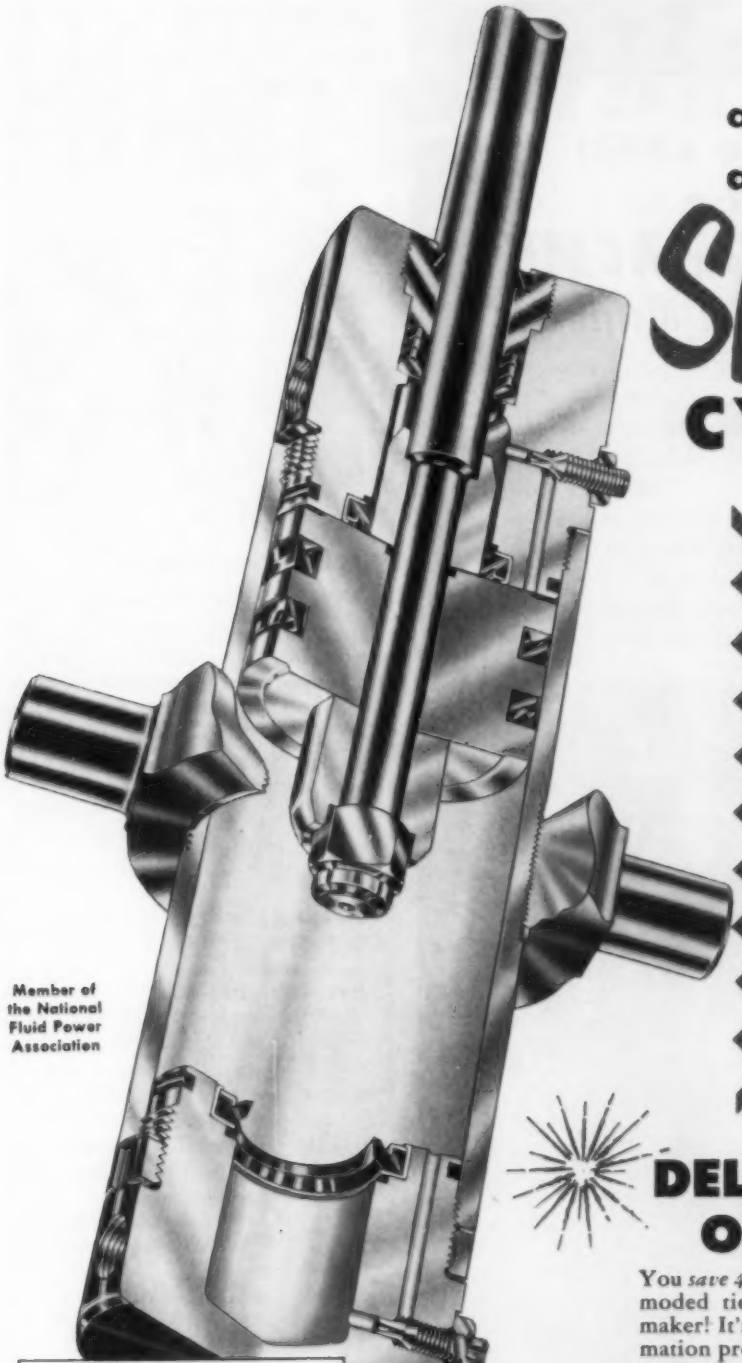
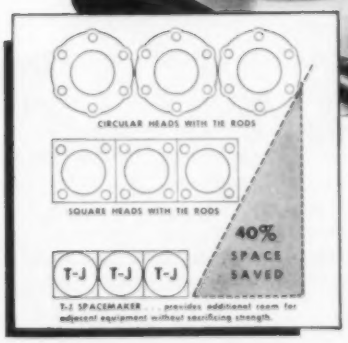
See us at Booth 421, Design Engineering Show, May 20-23rd, N. Y.

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



Member of the National Fluid Power Association

- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER,** not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

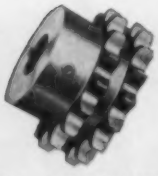
DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

STOCK BORE SPROCKETS



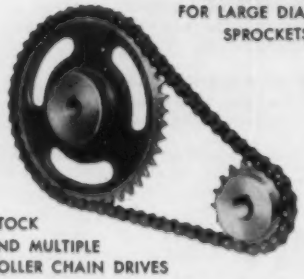
STEEL AND CAST IRON SINGLE SPROCKETS

CAST IRON HUB SPROCKETS

off the shelf service from your ACME industrial distributor

For off-the-shelf service on stock items, or quick deliveries on specials, your ACME distributor is fully equipped to meet your needs. His engineering experience, his facilities and know-how, and his draw on the largest stock of chain drive items in the country make him a useful man for you to know. Contact him now!

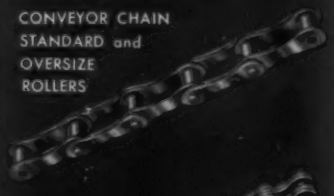
ALL STEEL SPLIT OR SOLID HUBS FOR LARGE DIAMETER SPROCKETS



STOCK AND MULTIPLE ROLLER CHAIN DRIVES

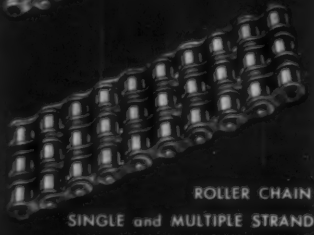
FREE CATALOG

Write Dept. IL for your 80 page copy of Acme's latest catalog. Packed with valuable data.



CONVEYOR CHAIN STANDARD and OVERSIZE ROLLERS

CABLE CHAIN



ROLLER CHAIN SINGLE and MULTIPLE STRAND

Call ACME for Service

Acme Chain Corporation

HOLYOKE MASSACHUSETTS

Superior Valve & Fittings Co., 1509 W. Liberty Ave., Pittsburgh 26, Pa.

For more information—
Circle 87, inside back cover

Teflon Hose Assembly

Hose assemblies consisting of extruded Teflon tube with stainless steel wire braided covering designed to withstand working pressures to 3,000 psi and temperatures to 500 F (when working pressures are not above 1,000 psi). Available from $\frac{3}{8}$ to $1\frac{1}{8}$ in. Flexonics Corp., Maywood, Ill.

For more information—
Circle 88, inside back cover

Strainer Tells When To Clean

A device that tells when this hydraulic strainer is clogged acts as a by-pass valve. A red signal notifies the operator when the strainer is clogged and has been pulled aside by pump suction to allow the free flow of oil around it. Rosaen Co., 1776 E. 9 Mile Road, Hazel Park, Mich.

For more information—
Circle 89, inside back cover

ENGINEERING MATERIALS

Glass Fiber Insulating Tapes

These tapes are available in black, orange, blue, yellow, red, green, brown, and white. Woven of continuous filament glass yarns, the tapes can be used as coil wrappers, protective coverings, conductor insulating, mechanical reinforcements and similar applications in electrical apparatus

(Continued on page 316)

HOWELL MOTOR BRIEFS

Quick facts for those who apply and specify electric motors

Installation Facility: Bonus Value in Motors

When you specify electric motors, do you consider their "installation facility" — the ease and freedom from difficulties with which motors can be put in use? It's a bonus value that can cut costs in your final assembly or in your customer's plant (wherever the motors are installed).

Steel Feet, Steel Frames Take Punishment Best

Howell Series 100 motors, with the new, smaller dimensions, have heavy steel feet welded to die-formed steel frames. No cracking of cast iron frame or mounting foot here. When a workman drops a motor down too hard, or applies that last excess twist of a wrench to a mounting bolt, Howell's tough steel frame and mounting feet can take it.

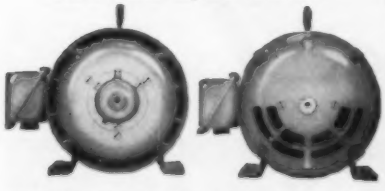
Howell's steel frame construction does much to avoid the delay and expense of motor replacements at the time of final machine assembly.

Position-Identified Leads Insure Correct Wiring

Leads on Howell Series 100 Motors are designated on the nameplate by their positions at the entrance to the conduit box. Each position is identified by an easily read, raised numeral on the neoprene lead block that seals the entrance from the motor. There are no tags, strips or clips to become lost or illegible.

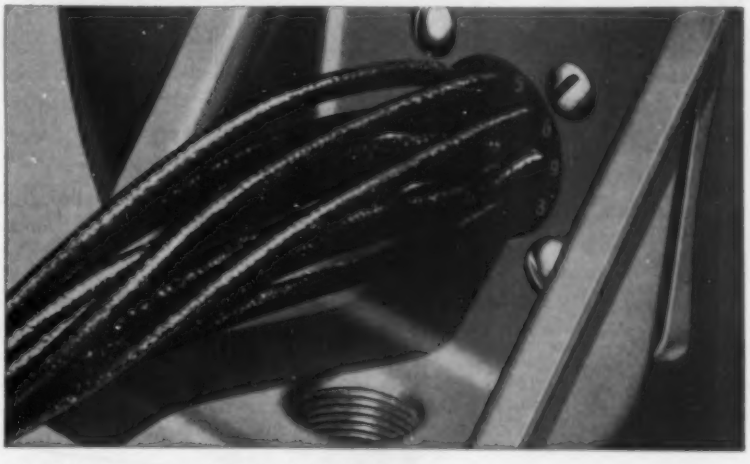
Howell lead identification not only speeds the original installation, it's permanent for easy re-installation, at any time during these motors' long working life.

Interchangeable TEFC and Open Motors



Totally enclosed fan cooled and open-type motors in Howell's Series 100 have the same diameter and mounting dimensions. This simplifies space allocation in your machine designs and allows quick, easy substitution of one type for the other in the field.

Resilient steel feet of Howell motors take any kind of stress during installation. Pads are ground flat after stator assembly to insure perfect mounting alignment.



Howell leads are permanently identified where they enter box from motor. Note time-saving, integral threaded nipple and easy four-way rotation of box to take conduit from any direction.

Get the details on all the bonus features of Howell Series 100 Motors — Write for Bulletin N-100-R

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Just place and trace

Lightweight, portable tracing unit is only 1 7/16 inches *thin*.

Now you can trace *right at the drawing board*, and save precious minutes with PORTA-TRACE—the thin, lightweight tracing box that *comes to you*.

Simply pick it up . . . place it on your board . . . flick a switch and you're ready —in seconds!

Only 1⅜ inches deep, PORTA-TRACE can actually be used under the straight edge of your drafting table! Its flush top permits use with drawings larger than unit itself. Strong Plexiglas top is enclosed by rugged, long-life stainless steel frame. Available in four sizes up to 24" x 36".

Save drafting time and precious space with PORTA-TRACE. Call your local Ozalid representative or write Ozalid, Dept. 0-4, Johnson City, N. Y.

Porta-trace

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Products for Design

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How many of these

NEW SPICER PRODUCTS

can you use?

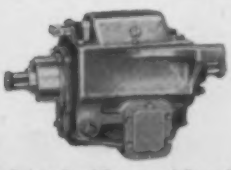
Spicer Split-Torque Clutch

Spicer Center Bearing Mounting for Propeller Shafts

Spicer Model FA Power Take-Off

Spicer Air-Assist Shift for Spicer Synchronized Transmissions

Spicer Telescoping Propeller Shaft Assembly

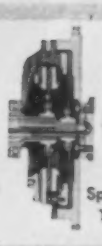


Spicer Dual-Purpose 4-Speed Auxiliary Transmission

Spicer Heavy-Duty Clutch

Spicer 1480 Series Universal Joint

Spicer POWR-LOK Differential Unit and Spicer Axle with POWR-LOK Differential



Spicer Two-Stage Tractor Clutch

Spicer Universal Joint Seal

Spicer 7231 3-Speed Auxiliary Transmission

THESE are new and recently-announced Spicer units . . . each one evidence of the ingenuity of Dana engineers in meeting today's fast-changing needs in power transmission!

Creative ability, and the talent for putting *action* into thoughts and plans, come naturally to the Dana engineering staff.

Since 1904, they have worked hand in hand with the manufacturers of every type of automotive vehicle . . . employing every type of power . . . and using every power transmission principle.

The complete line of Spicer products . . . produced by skilled personnel in 10 great and modern Dana plants . . . can serve you fully, completely, dependably!

DANA

Spicer

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SPICER PRODUCTS: Transmissions • Universal Joints • Propeller Shafts • Axles • Powr-Lok Differentials • Torque Converters • Gear Boxes • Power Take-Offs • Power Take-Off Joints • Rail Car Drives • Railway Generator Drives • Stampings • Spicer and Auburn Clutches • Parish Frames • Spicer Frames

SELF ALIGNING SHAFT—
linear motion
potentiometers

BOURNS
ALIGN-O-POT*

—highly reliable
despite misalignment
of actuating member

Here is a far-reaching advance in linear motion design. This unit allows for misalignment between the instrument and actuator—eliminating shaft side loads. With no alignment needed, the unit is mounted and installed quickly...is easily designed into a system.

To insure low noise characteristics under extreme vibration, the ALIGN-O-POT wiper assembly is supported throughout its entire travel by parallel guide rods. This provides continuous support directly at the point of contact...multiple contacts are used to further increase the reliability.

The ALIGN-O-POT has a stainless steel case and a flexible cable with plug connector. Standard travels are available from ½" to 6½". Other travels can be provided up to 36". The ALIGN-O-POT is fully tooled and in production.

BOURNS
LINIOMETER®

high performance
under environmental
extremes

The LINIOMETER has a bushing-supported shaft and the same highly reliable internal construction as the ALIGN-O-POT—for use where the self-aligning feature is not applicable. Small cross-section and optional mounting configurations are added features of these units. Available in standard travels from ½" to 6½".

the complete line of linear motion potentiometers

Bourns offers a wide selection of standard instruments for any need from ⅛" to 36" travels—all built for maximum reliability and optimum performance. Bourns will work with you on special requirements.
Write for technical literature.

*TRADE MARK

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TRIMPOT® • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

from small relay coils to large turbogenerators. Russell Mfg. Co., 288 E. Main St., Middletown, Conn.

For more information—
Circle 90, inside back cover

Flexible Teflon Tube and Rod

Spaghetti tubing with both thin and standard walls is made of Teflon, along with flexible tubing, rod and heavy wall tubing. All are cut in lengths to meet individual requirements. Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38 St., Philadelphia 4, Pa.

For more information—
Circle 91, inside back cover

Bonding Agent for Nylon

This is an epoxy-based compound designed to bond Nylon to itself, to metal, or to other materials. Dept. 119, Carl H. Biggs Co., 2255 Barry Ave., W. Los Angeles, Calif.

For more information—
Circle 92, inside back cover

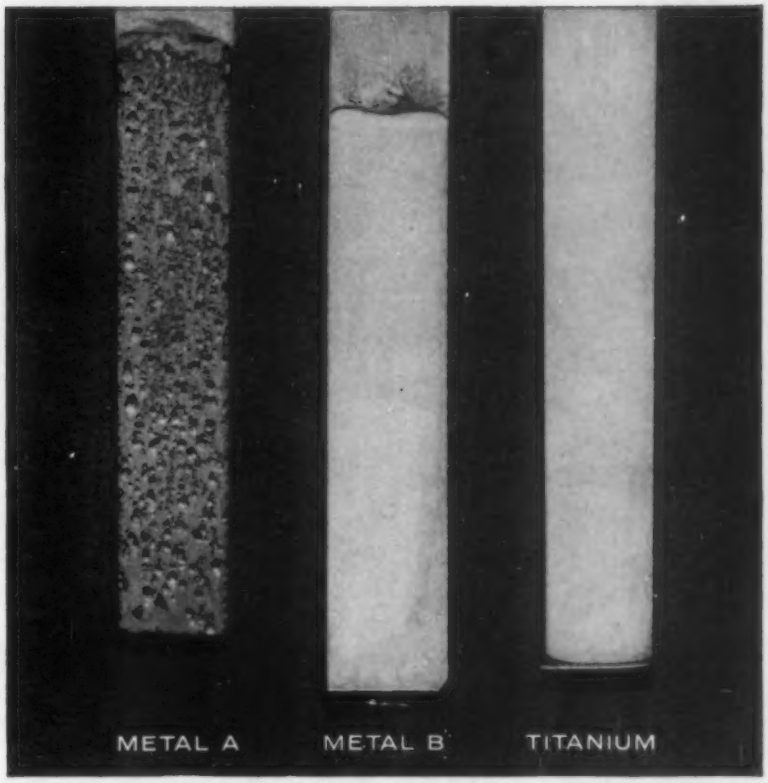
Oil and Air Hardening Flat Ground Die Steel

More than 1300 standard stock sizes of flat ground die steel for a variety of tool and die applications are available in both oil-hardening and air-hardening analyses. A surface-finish of 25-35 micro-in. is provided.

The oil-hardening type is a high grade molybdenum alloy tool steel. The air hardening type is a 5% chrome alloy. The oil hardening type is available in 18 and 36 in. lengths, in widths from ¾ to 14 in., as well as in a wide variety of stock sizes. Air-hardening type comes in 36 in.

(Continued on page 320)

Progress
with
TITANIUM



Test strips of three different metals after partial immersion for 24 hours in the same solution containing 10% nitric acid and 20% ferric chloride. Only titanium was unaffected. Both metal "A" and "B" are commonly used in corrosive processing applications.

TITANIUM

...the lowest cost material of construction?

● Although known as a high-priced metal, titanium is actually the lowest-cost material available in a surprising number of applications. For titanium has exceptional resistance to many corrosive media that severely attack other specialty metals.

To evaluate the economies of titanium try it where you have severe corrosion problems. Test and operating data indicate outstanding performance in contact with some of the most troublesome industrial chemicals—nitric acid, moist chlorine, chlorinated organic or inorganic compounds, etc.

As to *original* cost of titanium, per-pound price is not indicative, since titanium weighs only 56% as much as steel. Also, fabrication and other costs of any equipment usually far outweigh the material costs. On the basis of typical processing equipment which has been produced, the use of titanium versus stainless steel increases original cost by a factor of 3. Where there are substantial savings in replacement and down-time, titanium quickly pays for itself. Titanium in several cases has lasted up to 15 times longer than conventional materials.

Let us help you evaluate titanium. It may well be the lowest cost material of construction for your processing equipment. You can obtain Mallory-Sharon titanium and titanium alloys in standard shapes. For booklet on Titanium Corrosion Properties write Dept. P-2.

TYPICAL PRESENT APPLICATIONS OF TITANIUM

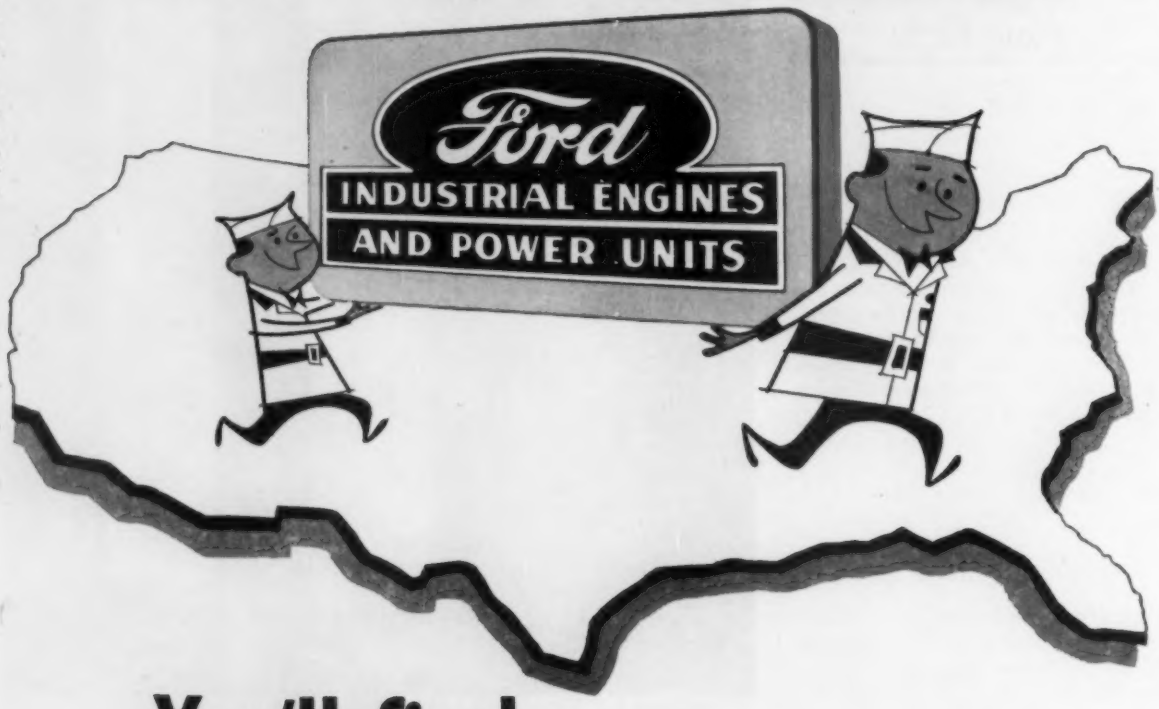
Anodizing racks	Impellers
Condenser inserts	Piping
Filters	Process vessels
Heat exchangers	Steam jet diffusers

MALLORY Ti SHARON

MALLORY-SHARON TITANIUM CORPORATION · NILES, OHIO

Producers of titanium and titanium alloy sheet, strip, plate, rod, bar, billets

Whether it's repair or replacement...



You'll find Ford Industrial Engine Service is available everywhere!

Know why so many industrial power users are swinging over to *Ford* power? One reason is service.

Ford power users *know* there's always a Ford Dealer nearby to give service when it's needed . . . to keep downtime at a minimum. And because Ford Dealers carry an inventory of the more commonly purchased engine parts, the Ford power user need never invest in a big parts inventory of his own.

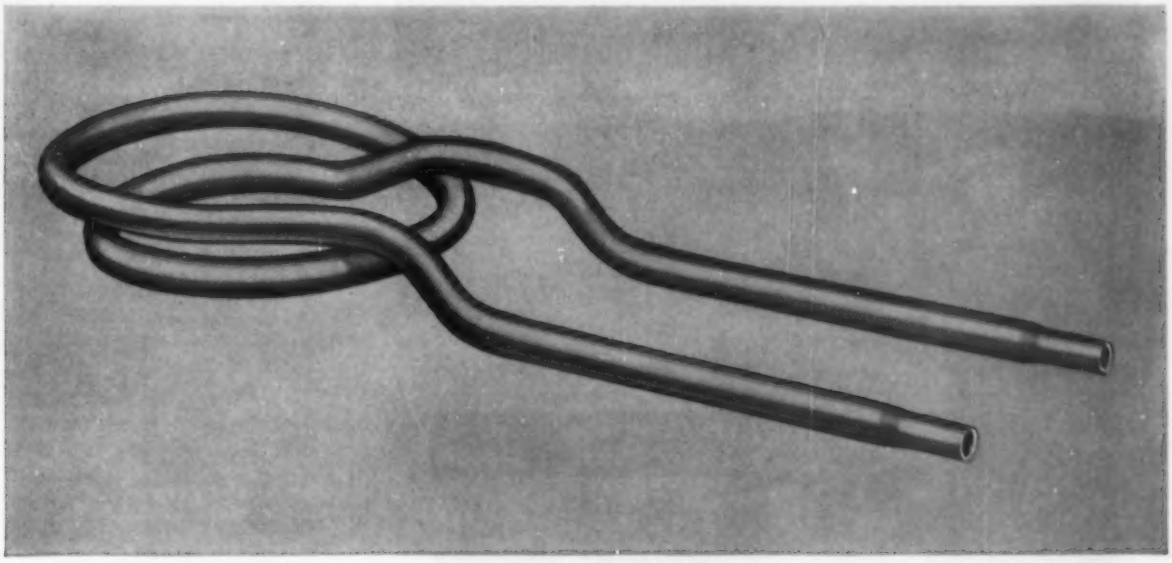
Also, across the country, you'll find a network of newly established Ford Industrial Power Headquarters. Each is equipped to repower any type of equipment with dependable, low-cost Ford power.

It's the availability of service like this—wherever you are—that helps keep your operating costs *low*. If you are considering a new power unit or engine assembly—4-, 6- or 8-cylinder—see your Ford Industrial Products Dealer. He will be very happy to discuss your power requirements with you and make sure you get the one right power unit for *your* job. Write to the address below for further information.

Ford
INDUSTRIAL ENGINES
AND POWER UNITS

INDUSTRIAL ENGINE DEPARTMENT • FORD Division of FORD MOTOR COMPANY
P.O. Box 598, Dearborn, Michigan

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED!



Complex shape of this oil-cooler tube lets it clear moving parts inside a compressor. Swaged ends are ready for brazing.

Bundy helps design a steel pretzel; bends it for Kelvinator compressor

Designing a compressor oil-cooler tube is tricky. It must bend like a pretzel to clear moving parts; stand up to punishing vibration indefinitely . . . yet be mass-produced quickly and economically. So when the problem arose, Kelvinator Division of American Motors Corp. consulted with the tubing experts—Bundy® design engineers.

Working together, Kelvinator and Bundy designers carefully plotted the intricate bends needed for clearance within the compressor. Next, their design took form in Bundyweld® Tubing. Bundyweld is ductile enough for easy fabrication . . . strong enough to withstand vibration fatigue . . . yet costs less than the material used in previous designs. Finally, the job was turned over to Bundy's modern tubing-fabrication facilities for mass production.

This is but one of the countless problems solved by teamwork between Bundy and our customers in many industries. In addition to years of experience, we have the advantage of working with Bundyweld—the only small-diameter tubing made by the exclusive process shown below. *Leak-proof by test*, Bundyweld is the safety standard of the refrigeration and automotive industries . . . *is used on 95% of today's cars, in an average of 20 applications each.*

If you have tubing design or fabrication problems, Bundy has the answers. It will pay you to call, write, or wire us today!

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ¾" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

If you need BEARINGS with UNUSUAL CHARACTERISTICS such as . . .

HEAT RESISTANCE —
to 500° – 1000° – 1500° F
NON-MAGNETIC PROPERTIES,
electrical conductance, etc.
RESISTANCE TO CORROSION
by Acids – Caustics – Salts
SPECIAL SHAPES AND SIZES,
low torque, ultra precision . .

. . . very likely, we can supply them — designed and built to your own specific requirements — in experimental or production quantities. We've been doing that for years, for well-known companies — often working closely with their own engineers. So, if *you* need special anti-friction bearings for *any* purpose, let's talk it over.

Free 32-page Bearings Bulletin tells about the factors involved in special bearing applications, and describes our work in this field. *Write for it!*

INDUSTRIAL TECTONICS, Inc.

3674 Jackson Rd., Ann Arbor, Michigan
18303 Santa Fe Ave., Compton, California

PRECISION BALLS OF ANY SIZE OR MATERIAL
ANTI-FRICTION BEARINGS FOR SPECIAL REQUIREMENTS
TOOLING BALLS — MASTER BALLS — SPHERICAL FINISHING

lengths in a wide range of widths and thicknesses, including squares. Heller Tool Co., Newcomerstown, Ohio

For more information—
Circle 93, inside back cover

Cementable Teflon Tapes

Cementable, glass cloth-reinforced and non-reinforced Teflon tapes can be bonded with ordinary adhesives to practically any surface, including metal, plastics, glass, wood, ceramics, and rubber. They are produced in widths from ¼ to 12 in. and in thicknesses from 0.002 to 0.060 in. The tapes are available with either one or both surfaces treated for adhesion. The cementable surface is produced by treatment with a sodium-ammonia mixture. Continental-Diamond Fibre Corp., Newark, Del.

For more information—
Circle 94, inside back cover

Chemically Shrunk Orlon Felts

These felted Orlon materials are available for industrial wet and dry filtration applications and other uses where a complete felt structure is preferred. The felts are currently manufactured in weights ranging from 8 oz to 8 lb per square yard. American Felt Co., Glenville, Conn.

For more information—
Circle 95, inside back cover

Asbestos Fiber Gaskets

Sharp bending will not cause this asbestos material to pipe or crack. Unusual compressibility is said to be

(Continued on page 324)

New Design Trends for

Harvey Aluminum Extrusions

To any experienced engineer or designer, aluminum extrusions are a common commodity. You don't have to tell him that extrusions offer such advantages as ease of fabrication, design flexibility, etc. He knows that. What he wants to know now are the newest advances made possible by the extrusion process.

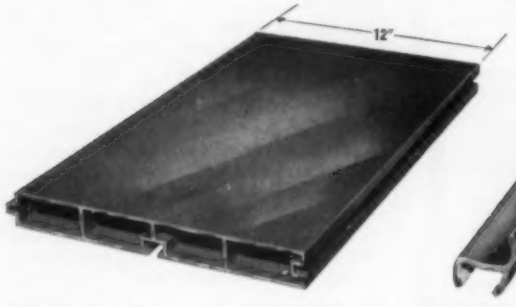
Potential for new configurations and applications

Typical new applications for Harvey Aluminum Extrusions are illustrated below. The design possibilities for aluminum extrusions are now practically limitless. Large heavy press sections; unusually complex shapes; wide, integrally stiffened skin panels; solid, hollow, and stepped extrusions; and extra long thin sections can be obtained from Harvey in all aluminum alloys. Heat-treated shapes can be produced in lengths up to 80 feet, weighing as much as 2,500 pounds. The maximum circumscribing circle diameter practical is 25½ inches. For functional, structural, or decorative applications demanding custom design plus light weight, corrosion resistance, high strength, and a naturally attractive finish, Harvey Aluminum Extrusions are first choice. And remember, Harvey is traditional for high quality and service.

Harvey Aluminum leads in extrusions

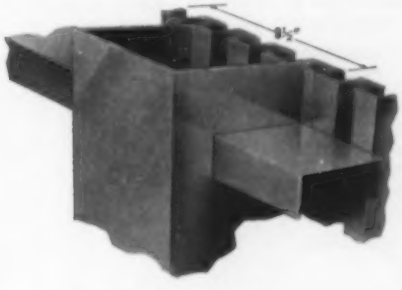
Harvey's completely integrated facilities include a large complement of extrusion presses ranging in size from 1400 tons to 12,000 tons, stretch-straighteners up to 3,000,000 pounds capacity for lengths up to 105 feet, and the newest supporting and finishing equipment.

If you have a problem with extrusions, thoroughly qualified Harvey specialists are always ready to help you improve your product. Write to Harvey Aluminum Sales, Inc., Torrance, California, or contact the nearest sales office listed under "Aluminum" in your classified telephone directory.



PANEL for highway signs. Extruded aluminum shape offers maximum strength and economy. Design combines several functions within a single shape. Light weight eases erection. Aluminum's natural, attractive finish and resistance to corrosion minimizes maintenance.

AUTOMOTIVE WINDOW FRAME combines utility with natural brilliance, eliminating costly plating operations. Rust is never a problem. This extruded shape typifies the trend in using aluminum for both decorative and functional applications in the automotive industry.



STRUCTURAL ASSEMBLY of extruded shapes is utilized for large span hanger and warehouse doors, building walls, and other components. Both structure and enclosure are formed by combining two aluminum extrusions. Interlocking design speeds and simplifies erection.

Making the most of aluminum . . . for everyone

HARVEY ALUMINUM SALES INC., TORRANCE, CALIFORNIA

HARVEY Aluminum

Harvey is a leading independent producer of quality aluminum products in all alloys and sizes: Rod and bar, pipe, tube, hollow sections, press forgings, forging stock, impact extrusions, structurals, special shapes, extrusions, screw machine products and other aluminum products. Harvey is also producing similar items in titanium and steel.

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

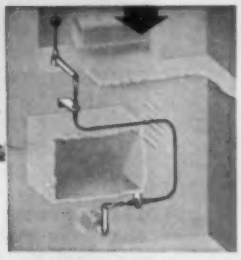
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

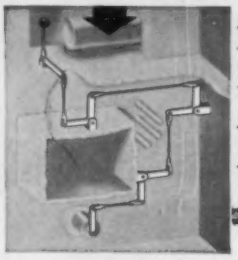
***Advantages** of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

TRU-LAY PUSH-PULL

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



MECHANICAL LINKAGES



Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.

WHERE SPACE AND COSTS ARE TIGHT

SAVE on both... with AMP'S NEW FASTON lines

AMP's New Faston Terminals (straight-on and flag types) are especially designed for use in toasters, irons, mixers, griddles, or other traffic appliances where space limitations prohibit the use of standard-size Faston Terminals.

These new Faston Terminals are the only receptacles engineered to fit .205, .187 and .110 tabs, now included on devices produced by leading appliance component manufacturers. Also, they are available with or without insulation support. The insulation-support feature has been added to accommodate applications subject to excessive vibration.

Application tooling for the new Faston line combines strip terminals and the AMP Automachine, to give highest quality of precision terminations at the lowest possible installed unit cost.

Make the new Faston line standard equipment on your product to save valuable space and reduce costs, without loss of electrical and mechanical performance.

Complete information is available on request.

AMP INCORPORATED

General Office: 5505 Eisenhower Blvd., Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada • Aircraft-Marine Products (G.B.) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP—Holland N.V. 's-Hertogenbosch, Holland

Japanese Distributor: Oriental Terminal Products Co., Ltd., Tokyo, Japan

The Apex Universal Joint Assembly that drives the pump unit in a Mateer Filler must stand up under the most difficult conditions . . . high-speed, precision operation . . . continuous, split-second starting and stopping.

Here's what the user thinks of Apex Universal Joint Assemblies: " . . . the success of Mateer Fillers depends upon the universal joints . . . we have been using Apex for almost 10 years and are completely satisfied".

Whatever you require of a universal joint, you'll find it in Apex Industrial Universal Joints and Assemblies. The complete line, including the exclusive Apex covered universal joints and assemblies, is described in our Catalog 28. Write, on your company letterhead please, for your copy.

APEX

THE APEX MACHINE & TOOL COMPANY
1039 S. Patterson Blvd. • Dayton 2, Ohio

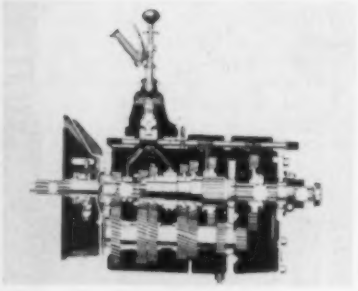
ATLANTA • BALTIMORE • BATON ROUGE • BIRMINGHAM • BUFFALO • CHARLESTON
CHICAGO • CLEVELAND • COLUMBUS (Newark) • DALLAS • DAVENPORT • DENVER
DETROIT • HOUSTON • INDIANAPOLIS • KANSAS CITY • LOS ANGELES • LOUISVILLE
MEMPHIS • MILWAUKEE • MINNEAPOLIS • NEW ORLEANS • NEW YORK CITY • OAKLAND
PHILADELPHIA • PITTSBURGH • PROVIDENCE • ROCKFORD • ST. LOUIS • SEATTLE
SHREVEPORT • SOUTH BEND • SYRACUSE • WICHITA

another characteristic of these new asbestos compounds.

In test installations, the asbestos gasketing showed perfect sealing performance with minimum bolt torque loss where flange temperatures were up to 500 F, and internal liquid pressures up to 500 psi. These new compounds are available with styrene-type rubber binder, nitrile-type rubber binder, and chloroprene-type rubber binder. All are available as roll goods, sheets, or die-cut parts. Armstrong Cork Co., Lancaster, Pa.

For more information—
Circle 96, inside back cover

MECHANICAL COMPONENTS



Transmission for Smaller Equipment

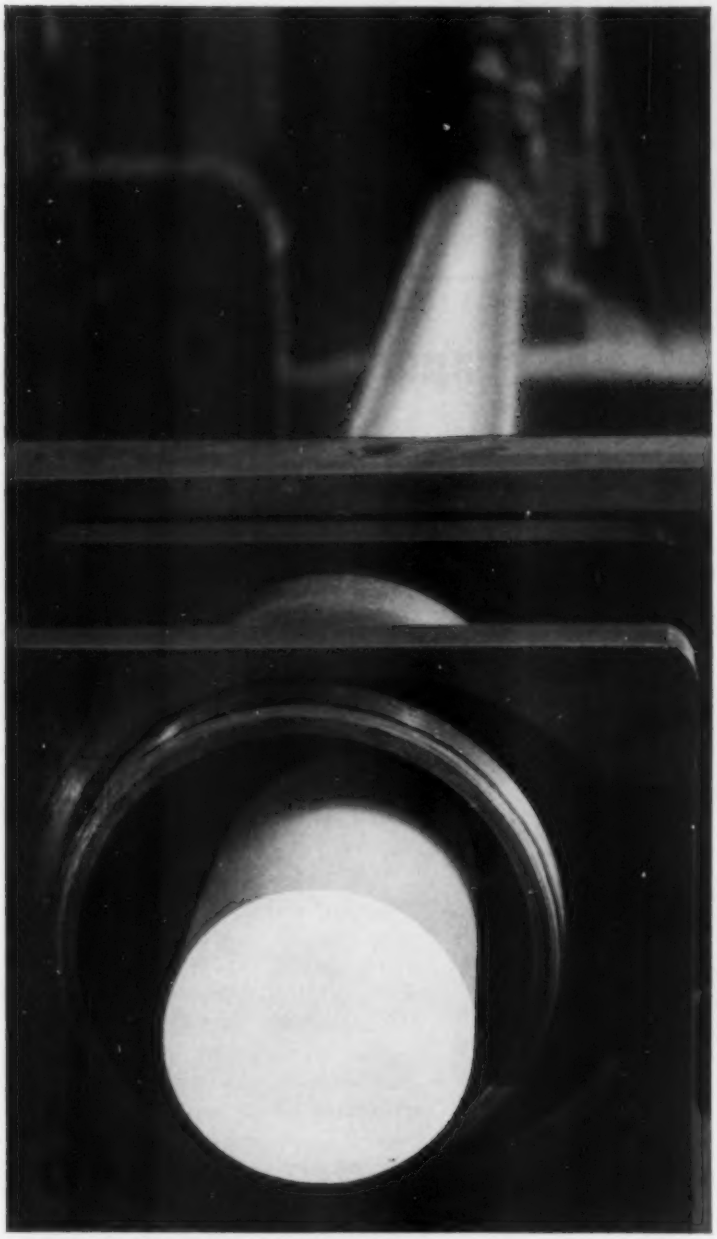
Designed for gasoline engines up to 400 cu in. piston displacement, this transmission provides seven forward speeds available in progressive and selective steps, with closely spaced and equal ratios in the operating range. The seven forward speeds, and one reverse, are shifted by a single lever—there is no gear splitting. Weight is 375 lb, length, 26 $\frac{3}{4}$ in. Fuller Mfg. Co., Kalamazoo, Mich.

For more information—
Circle 97, inside back cover

Straight and Angular Hand Wheels

Both types of wheel are aluminum castings, plain or finished, with or without lug for revolving handle. Straight hand wheels are now available in 6, 8, 10 and 12 in. dia; angular hand wheels in 4, 5, 6, 8, 10, 12, and 14 in. dia. New 4 and 5 in. wheels are solid disc type, without

(Continued on page 328)



FAMOUS NYLON JOINS NATIONAL'S MATERIALS FAMILY. Proved in thousands of tough applications, versatile Nylon now becomes more useful to the designer than ever. National makes it so in extruded rods and 100% usable finished fabricated parts. Standard rod sizes range from ¼" through 2" in 3 and 6-foot lengths. Inquiries on other sizes and shapes are invited. National's expert engineering counsel assures the commercial soundness and economy of your product. And men, machines and capacity place National in a unique position to serve your immediate needs.

NATIONAL CAN HELP YOU reduce unit product cost or improve product performance at no added cost. Here's why: You can select the "one best material" from over 100 grades of PHENOLITE®, Vulcanized Fibre and NATIONAL Nylon—*without compromise in* properties or cost. You can simplify production and purchasing with the *timed delivery* of 100% usable parts—*from a single reliable source*. You gain competitively with National's new materials and grades —*the direct results of programmed materials-research*.

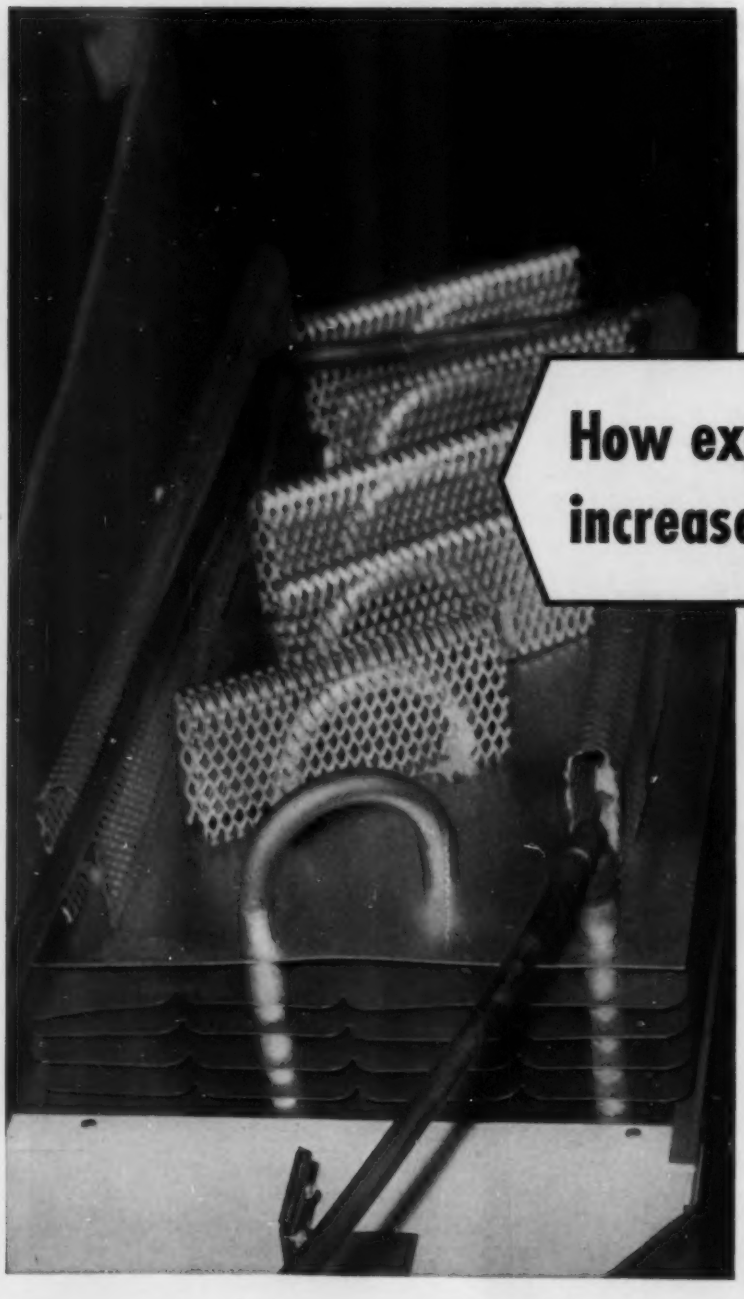
You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware, Dept. H.

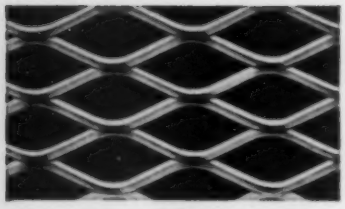
MACHINING SKILL GIVES 100% USABLE PARTS as exemplified by this precision-turned 4-40 thread screw of Nylon. National has the skills and equipment to fabricate almost any part you design. Whether your order requires the simplest punching process or the most complex screw machine operation, you get the same result: *100% usable parts.*

INDUSTRY'S BROADEST LINE OF BASIC MATERIALS gives you greatest design freedom. With the addition of Nylon, the National line of materials—already industry's most extensive—grows to more than 100 grades and combinations. These include Vulcanized Fibre and PHENOLITE® Laminated Plastic. The result is greater selectivity for you—unbiased recommendations from National—and virtually any combination of properties you desire.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario





How expanded aluminum increased coil efficiency

Anheuser-Busch, Inc., St. Louis, Mo., used Penmetal expanded aluminum in their freezing units to cover the exposed ends of the evaporator coils. This expanded aluminum provided additional prime surface for frost collection on the cooling coils and fins—thus increasing the efficiency of the unit.

But Anheuser-Busch found other advantages in expanded aluminum. Cooling air circulates freely through the open mesh . . . it won't rust . . . can't ever loosen . . . and was easy to shape.

Does the success of this manufacturer open your eyes to a new possibility for solving some problem of your own by using expanded aluminum? Write today, for a reference copy of booklet 507 EM. No cost or obligation.

Penmetal expanded aluminum used to cover exposed ends of evaporator coils in Anheuser-Busch refrigerator-merchandiser.

PENN METAL COMPANY, INC.

General Sales Office:
40 Central Street, Boston 9, Mass.

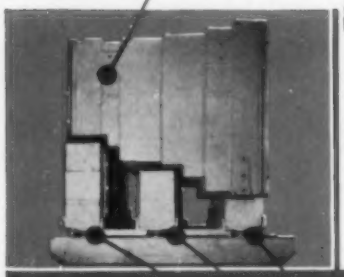
Plant: Parkersburg, W. Va.

District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

Penmetal

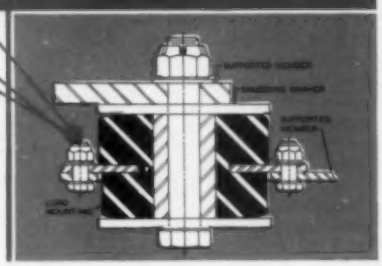
PM-129

radiation shielding windows protected in transit by LORD shipping mountings



Lord bonded rubber mountings provide a resilient but stable base for shipping massive glass casting.

Corning window is supported by eight Lord Heavy Duty Plate Form Mountings equipped with snubbing washers which limit and cushion excessive shock movement.



■ These 5000-pound glass castings used as shielding windows against nuclear radiation posed some unusual shipping problems.

Transporting these observation windows from the Harrodsburg, Ky. plant of Corning Glass Works to the installation sites exposed them to costly and irreparable damage. The weight, and irregular shape of the windows complicated the problem.

Lord research and engineering produced an economical solution by flexibly supporting the windows on eight Lord bonded rubber mountings. The mountings isolate vibration and reduce shock which might damage the glass. This move has paid off for Corning—no windows shipped on Lord mountings have been damaged!

If damaged shipments are costing you time, money and poor customer relations, take advantage of Lord's experience and facilities. Contact the Lord field engineer nearest you or the Home Office, Erie, Pa.

ATLANTA, GEORGIA · CEdar 7-1123
BOSTON, MASS. · HAncock 6-9135
CHICAGO, ILL. · Michigan 2-6010
CLEVELAND, OHIO · SHadyside 9-3175
DALLAS, TEXAS · Riverside 1-3392
DAYTON, OHIO · Michigan 8871
DETROIT, MICH. · TRinity 4-2060
LOS ANGELES, CAL. · HOllywood 4-7593
NEW YORK, N. Y. · Circle 7-3326
PHILADELPHIA, PA. · LOcust 4-0147

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA

LORD
BONDED RUBBER

designers and producers of bonded rubber products since 1924

WHY *Cambridge* WOVEN WIRE BELTS

mean low cost, continuous processing

By providing belt-to-belt movement at controlled speeds, woven wire conveyor belts eliminate batch handling, increase product uniformity and production capacity in all types of manufacturing. No matter what you're processing . . . metal parts, food products, chemicals, plastics, ceramics, glass . . . wet or dry, hot or cold . . . you can cut operating expenses all along the line by combining movement with processing. EXAMPLE:

Continuous Heat Treating

MOVING BELT carries a stream of brass light bulb ferrules through furnace for continuous, uniform annealing at 1400° F.

OPEN MESH of Cambridge belt allows free circulation of heat around the load so that hot spots are eliminated. Open mesh construction also permits rapid drainage in wet processes such as quenching and washing.

ALL-METAL BELT withstands heat up to 2100°F. (as in copper brazing) without damage, provides lasting strength because there are no seams, lacers or fasteners to break or wear.

SPECIAL RAISED EDGES hold parts on belt, are typical of variety of side and surface attachments available to hold your product during flat or inclined movement.

Regardless of your industry . . . metal-working, food, chemical, glass or ceramic . . . you'll find combined movement and processing practical and economical in machines for your own operation or for resale. Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy to do the job you want . . . hot or cold, wet or dry. Call your Cambridge Field Engineer to discuss how you can cut costs by continuous operation. Look under "Belting, Mechanical" in the Yellow Pages . . . or write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.

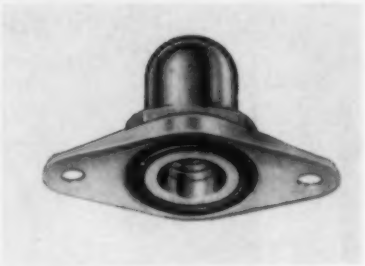
WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P, Cambridge 4, Maryland

OFFICES • IN PRINCIPAL INDUSTRIAL CITIES

spokes. Wheels from 6 to 10 in. dia. are standard four-spoke models. Jergens Tool Specialty Co., 712 E. 163 St., Cleveland 10, Ohio.

For more information—
Circle 98, inside back cover



Self-Sealing Floating Anchor Nut

The nut contains an integrally molded rubber seal to provide sealing. The nut element floats independently of the seal, to accommodate misalignment in assemblies. Temperature range is −80 F to 225 F. Kaynor Co., 820 E. 16 St., Los Angeles 21, Calif.

For more information—
Circle 99, inside back cover

Miniature Clutch

This device is said to make possible the engagement or disengagement of any or all parts of power transmission installations, such as tachometer or counter drives. Once readings or operations have been completed a slight turn of the control

(Continued on page 332)

. . . In the infinity of the future that begins in the next instant, people like yourselves . . . scientists, engineers and intelligent businessmen . . . will be dreaming of things for a better world. And these dreams . . . the formulas and the blueprints . . . will be rushed into realities because other men who believe in the future are now working to provide you with the methods and materials that will give wings to your imagination.

Your dreams will influence not only your own lives but the lives of millions of people. You will make food tastier and fresher. You will make sleep and relaxation more comfortable. You will control temperature to an even greater degree . . . to suit every human and technical need. You will make travel faster and safer. You will make communications more diversified, more dependable and more complete. You will manufacture the complicated devices of the atomic age by increasingly simplified procedures. In short, you will make life more enjoyable in many ways.

. . . And there is a NEW MIRACLE MATERIAL which will help provide an early fulfillment of these "dreams." The scientists who are now developing the wide range of properties inherent in this material cannot envision all of its applications. But you . . . the scientist, the engineer or the businessman with imagination . . . can work with the Research and Development staff of American Latex Products Corporation toward applications only *you* can dream of . . .

The future is now . . . this NEW MIRACLE MATERIAL IS HERE!

stafoam

A liquid . . . poured in place . . . foams and sets. The miracle material, STAFOAM, results. . . . A material with any set of characteristics pre-determined by YOU. It can be formulated to produce a material as hard as steel. It can be formulated to produce a material of sponge-like flexibility. Or it can be formulated to any density between these extremes. STAFOAM can have pre-determined strength, texture, rigidity, porosity, thermal characteristics, insulation characteristics (heat, cold, electrical, shock and sound), and color.

STAFOAM is a polyurethane foam, formed by mixing isocyanates and resinous polymers in liquid form. In some formulas, STAFOAM is thermo-setting; in others, it is thermo-plastic. Consider what just one of STAFOAM'S valuable characteristics . . . foamed in place . . . can mean in savings to your manufacturing process . . . in engineering, in tooling, in assembly and of course in labor. STAFOAM is a material that could well revolutionize your manufacturing methods . . . or even your product.

The applications of STAFOAM are limited only by your imagination.

STAFOAM is in your future.

☐ *Send me Brochure on Rigid Stafoam.*

☐ *Send me Brochure on Flexible Stafoam.*

AMERICAN LATEX
PRODUCTS CORPORATION
3341 West El Segundo Blvd., Hawthorne, Calif.

Please complete space below, tear off and mail.

Name.....

Title or Code No......

Company.....

Address.....

.....

How to Control Corrosion on Bare Aluminum

Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

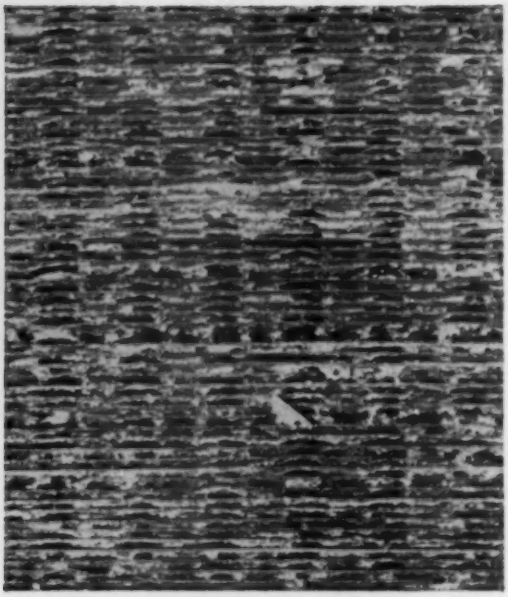
The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

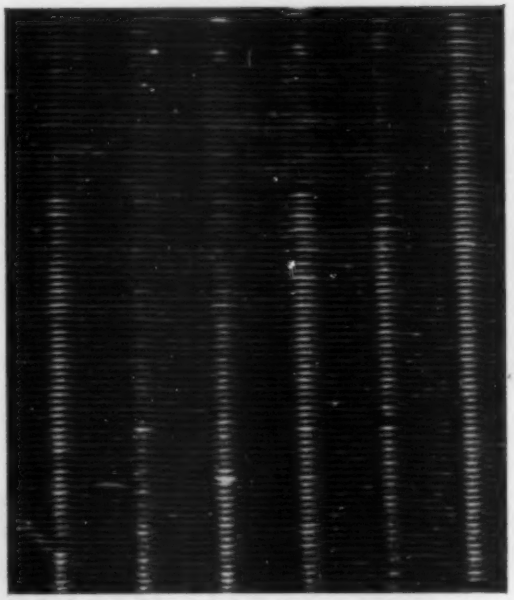
Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

The Parker man in your territory has valuable experience to share with you in treating aluminum and its alloys. A letter or phone call will bring him to you.



UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

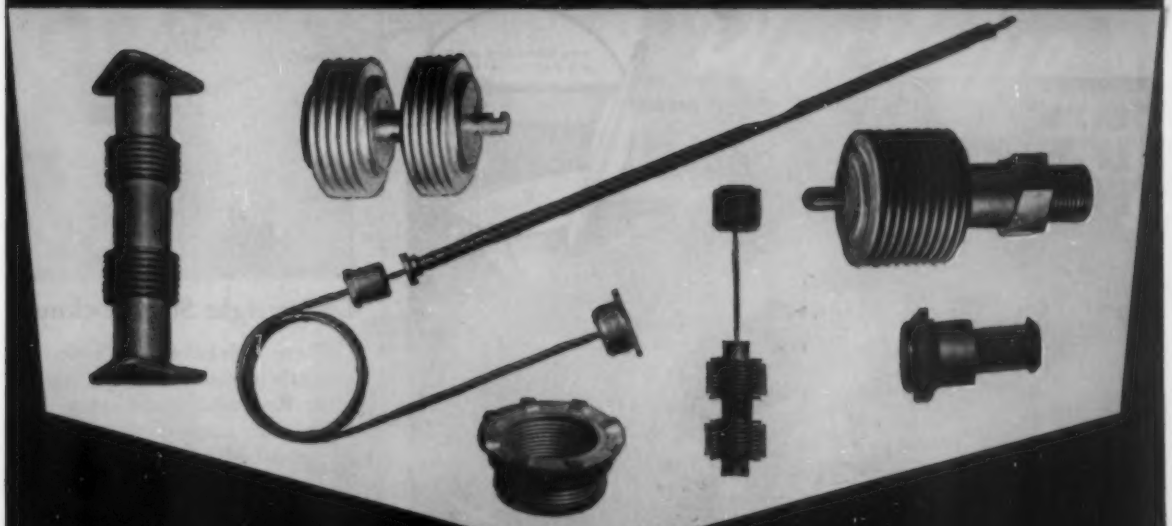
SINCE 1914—LEADER IN THE FIELD

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY
2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE corrosion resistant paint base
BONDERITE and BONDERLUBE aids in cold forming of metals
PARCO COMPOUND rust resistant
PARCO LUBRITE wear resistant for friction surfaces
TROPICAL heavy duty maintenance paints since 1883

HOW TO SAVE TIME AND MONEY ON COMPLETE BELLOWS ASSEMBLIES



No matter why or how the bellows principle enters into an assembly, Fulton Sylphon can assemble the right bellows and related accessories or mountings into a complete device that meets your specifications. In doing this Fulton Sylphon offers important design help, specialized skill in joining bellows with other members, and modern production facilities for on-time deliveries.

BELLOWS FOR INSTRUMENT ASSEMBLIES

are available with diameters, lengths, strokes, spring rates, metals and charges to provide a wide range of movements in high or low pressure systems. In all applications the exclusive Sylphon® bellows assures continuing accuracy and safety of operation. For one thing, cold-working production methods give it maximum resiliency for withstanding repeated cycling. In addition, its *seamless* design and the availability of multiple plies enable the Sylphon bellows to better resist pressure and other conditions.

Send for Bellows Catalog GP—1400

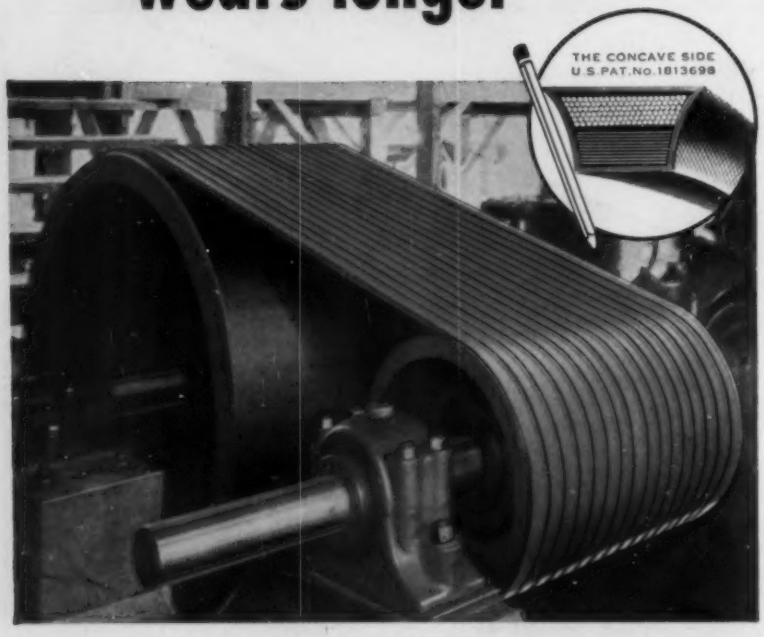
Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION, Knoxville 1, Tenn.

FULTON SYLPHON BELLOWS HEADQUARTERS U.S.A.

Why a V-Belt with CONCAVE SIDES wears longer



It is easy to demonstrate to yourself why the concave sides (Fig. 1) of the Gates belt greatly lengthen belt life.

Simply bend a Gates belt and feel the sides. Notice how these precisely engineered concave sides *fill out* on the bend and *become straight*. Thus a Gates belt grips the sheave groove evenly (Fig. 1-A) and wear is distributed uniformly across each side of the belt. That means longer belt life; lower costs.

Make the same test with a straight-sided belt (Fig. 2) and see what happens. The sides bulge out on the bend (Fig. 2-A) concentrating the wear at points shown by arrows.

To assure longer wear and keep belt costs down, specify the V-belt with Concave sides—Gates Vulco Rope . . . readily available from nearby distributor stocks. The Gates Rubber Company, Denver, Colorado—*World's Largest Maker of V-Belts.*

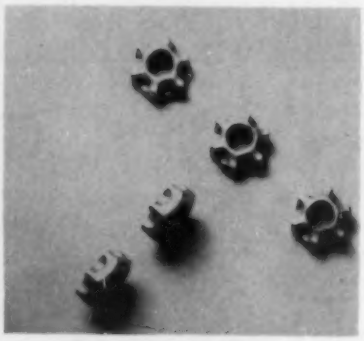
There are Gates Engineering Offices and Distributor Stocks in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA 90

Gates VULCO ROPE Drives

disengages the clutch until further readings are needed. Barbour-Stockwell Co., 205 Broadway, Cambridge, Mass.

For more information—
Circle 100, inside back cover



Lightweight Steel Locknut

These self-locking fasteners are presently available in 10-32 and ¼-28 sizes. Re-useability and other details of the nuts conform to both AN-N-10 and MIL-N-25027. Standard Pressed Steel Co., Jenkintown, Pa.

For more information—
Circle 101, inside back cover

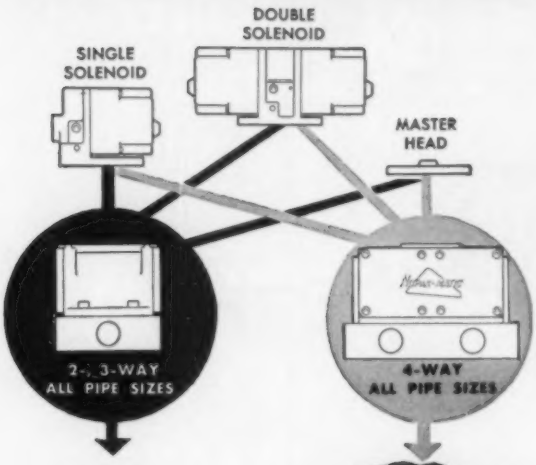
Hydraulic Transmission

This is a hydraulic, three-element, torque converter drive transmission for use in powered equipment. The converter and directional change transmission can be furnished matched to various air-cooled and liquid-cooled engines and is designed for simplified coupling to engine and final drive.

Directional change is accomplished by a dual multiple disc clutch arrangement which is controlled by a single forward, neutral, reverse position lever. Gears are steel, cut and shaved for quiet operation, and the extra heavy shafts are mounted on ball and roller bearings. Output shaft governor arrangement is optional.

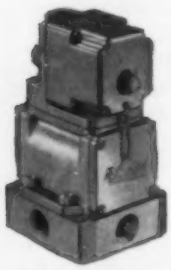
(Continued on page 334)

ONLY 3 PILOT HEADS fit all models

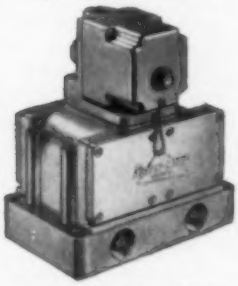


2-, 3-Way Master Valve

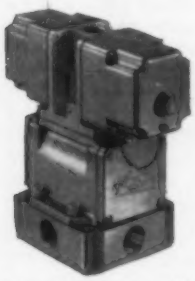
4-Way Master Valve



2-, 3-Way Single Solenoid Valve



4-Way Single Solenoid Valve



2-, 3-Way Double Solenoid Valve

4-Way Double Solenoid Valve

NOPAK-MATIC Plus Value Valves are available in ¼", ⅜", ½" and ¾" pipe sizes, for 2- or 3-Way Normally Open or Normally Closed or 4-Way operation with master (air), single or double solenoid pilot control heads.

Another *Plus Value* in NOPAK-MATIC poppet-type air control valves

Meet more air control needs with fewer valves

Nopak-matic valves, with exclusive automatic "Flow-Director" pilot heads, reduce valve and parts inventory. Fewer valves meet more application requirements.

Any pilot head (master, single or double solenoid), fits every valve regardless of type or size. Valves can be quickly converted from master to single or double solenoid control in a matter of minutes.

Other Plus Values in Nopak-matic

- **100% J.I.C. conformance at no extra cost.**
- **Exclusive "Flow-Director" pilot heads for more versatile application.**
- **Replaceable, self-cleaning seats.**
- **New, fast-maintenance design.**
- **Lightweight, corrosion-resistant construction.**
- **Split second response — Full flow.**

Get the Full Story!

SEND FOR CATALOG 105. It describes in detail all the NOPAK-MATIC Plus Values, and contains complete installation, dimension and parts data.

Specify **NOPAK** **VALVES and CYLINDERS**

GALLAND-HENNING NOPAK DIVISION • 2762 South 31st St. • Milwaukee 46, Wis.

A 6-603-1P

A good chair is like a good wife...if you choose with care, it will look after your comfort and aid you in your work for a long time to come

Cramer CHAIRS ARE

GOOD CHAIRS

Scientifically planned to aid YOU in your work . . . designed to support you comfortably whether you're chewing your pencil or bent over hard at work . . . engineered from the quality materials YOU would recommend, with independently adjustable seat, back and footring to conform to your physique . . . and with removable, replaceable covers in a wide range of fabrics and colors to match YOUR decorating plan.

Pictured, Cramer Hi-Model 4D-22T with forward-tilt seat; others available. All are low-gravity balanced for safe use on casters if desired.

LIKE MORE INFORMATION?

Cramer Posture Chair Co., Inc., Dept. PE47
1205 Charlotte, Kansas City 6, Mo.
Please send me complete facts on the Cramer Hi-Model chairs designed for working architects and engineers.

Name _____

Firm _____

Address _____

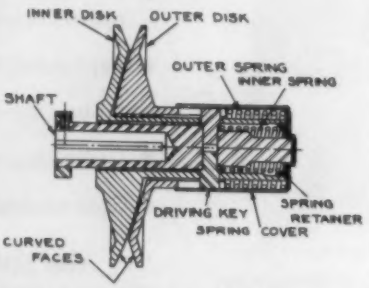
Design of the transmission makes it adaptable to smaller equipment in the 15 to 30 hp range. Prime-mover Co., Muscatine, Iowa.

For more information—
Circle 102, inside back cover

Right-Angle Worm-Type Gearmotors

With double-enveloping worm gearing, these gearmotors are offered in both standard extended shaft and shaft-mounted models. Standard NEMA D-flange motors are used, and gearmotors are available with or without motors as desired. Four different sizes are currently available to handle fractional to 15 hp motors. This range is now being extended to 40 hp. The gearmotors are available in 28 standard output speeds from 6.25 rpm to 525 rpm (which includes all standard AGMA output speeds). Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

For more information—
Circle 103, inside back cover



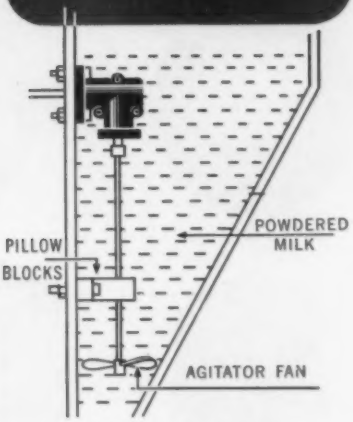
Variable Speed Pulleys

Variable speed pulleys rated at 1 and 1½ hp, 750 rpm, with a speed ratio of 2½:1, have oil-pregnated bronze bushings.

The pulleys take "B" section V-

(Continued on page 336)

ANGLgear solves contamination problem



Simplified drawing shows how ANGLgear drives discharge agitator fan in a powdered milk bin. ANGLgear's sealed lubricant feature protects product from contamination.

A well-known candy manufacturer needed a 90° power take-off to drive an agitator inside a powdered milk bin. Trouble was the lubricant from ordinary miter gears would contaminate the product.

The only answer seemed to be a costly nonstock drive with special seals . . . until company engineers learned about ANGLgear.

A standard Model R320 ANGLgear—completely enclosed, permanently lubricated — not only licked the contamination problem but also was inexpensive and easy to install.

Standardized ANGLgear is a simple, compact, positive 90° drive suitable for either manual or power operated systems. ANGLgear is available from stock in 1 to 5 hp ratings, with 2- or 3-way shafting, and 1:1 or 2:1 gearing.

See our literature in Sweet's Product Design File; then contact your local distributor or write direct.

AIRBORNE®

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

NEW HAMMARLUND RADIO RECEIVER

FEATURES DIE CAST PANEL

CASE HISTORIES FROM MT. VERNON FILES

In their new HQ-100, Hammarlund Manufacturing Company brings to reality a completely new concept in receiver design. It is beautiful. It gives the radio amateur the utmost in performance. And it sells for far less than other comparable short-wave receivers.

A chief reason for this great economy is the front panel—the first die-cast panel in the history of commercial radio equipment. This 3-dimensional, channeled die-cast aluminum panel is used because it affords both rigidity and great structural strength. To produce its equivalent in sheet metal —the currently used method in the industry—*would cost 4 times as much.*

This remarkable panel is the result of thorough collaboration between Hammarlund and the die-making experts at Mt. Vernon, who made practical suggestions which simplified its design.

In addition to the production economies of die casting, the panel benefits from these other important advantages: (1) Die casting's inherent accuracy enables Hammarlund to assemble the chassis with what they call "camera precision construction." (2) All rejects on the production line are eliminated. (3) In finishing—die casting enables them to work out clearly divided areas for the elegant two-tone treatment that is both functional and beautiful. Also, the amount of finishing is minimized.

When you are out to break precedent, as Hammarlund did, you too can find the kind of skilled help you need in the complete service available from Mt. Vernon's coordinated designing, die-making, casting, and machining facilities, all under one roof, which can supply die cast zinc and aluminum parts ready for use. A switch to a die casting service like ours may be your next step. Let's discuss it.

MT. VERNON DIE CASTING CORP.
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES

Mr. Grant Eller
6 East 194th St., Cleveland, Ohio

Mr. Jerome J. Theobold
9 East Genesee St., Skaneateles, N. Y.

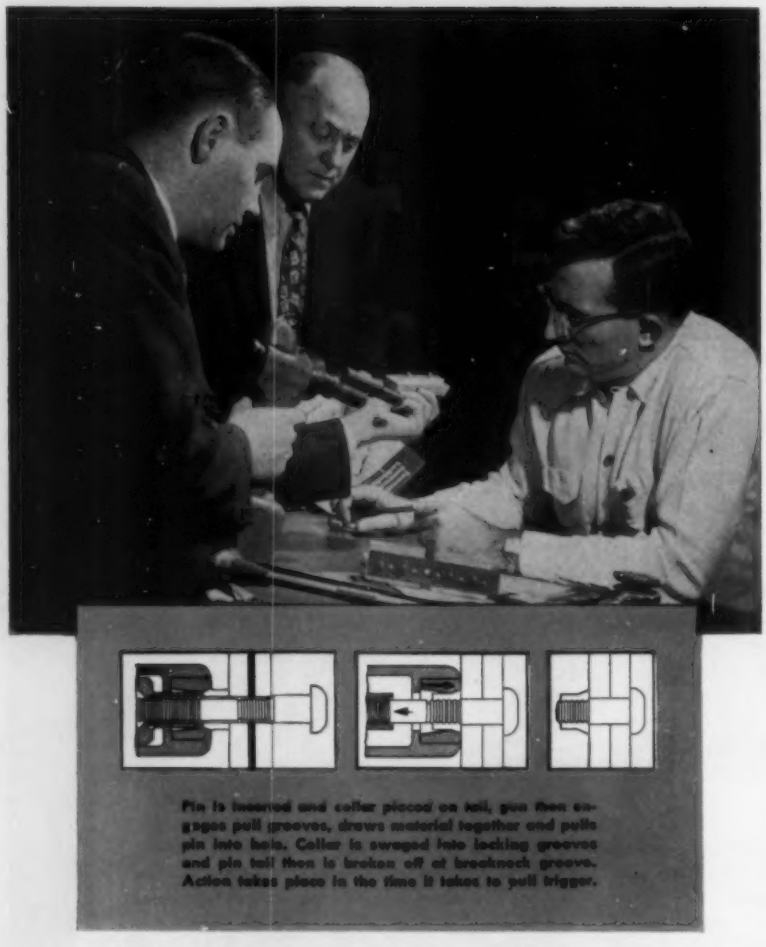
Mr. Arthur Diamond, Tools Incorporated
86 Bethlehem Pike, Philadelphia, Pa.

Mr. Anker Anderson
Cascade Road, Stamford, Connecticut

Mr. William Sauers
101 Briarcliff Road, Rochester, N. Y.

Mr. David King
230 Grant Boulevard, Syracuse, N. Y.

Mr. George E. Hahl
39 South Munn Ave., East Orange, N. J.


Pin is inserted and collar placed on tail, gun then engages pull grooves, draws material together and pulls pin into hole. Collar is swaged into locking grooves and pin tail then is broken off at breaknock groove. Action takes place in the time it takes to pull trigger.

This quick demonstration at your desk will show how to get superior, more economical fastening with TOWNSEND LOCKBOLTS*

In a few minutes we can show how Townsend lockbolts will give you superior fastening at lower installed cost and improve your products. A Townsend engineer will demonstrate the ease with which they can be installed, and prove their high resistance to vibration and shock.

Townsend lockbolts provide a higher clinch, or clamping action than rivets, and more uniform fastening than nuts and bolts. They fill the hole better than other fasteners, have high tensile pre-load, make a more rigid joint and provide an effective liquid seal. Available in both steel and aluminum alloy in a variety of diameters and lengths—two head styles.

For a demonstration of how Townsend lockbolts will improve your fastening while lowering the cost, write to Townsend Company, P.O. Box 237-D, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

See Lockbolts Demonstrated At The Design Engineering Show—Booth 1139

The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

belts. Model 175 is rated at ¾ hp at 1150 rpm and 1 hp at 1750 rpm; Model 180 at 1 hp at 1150 rpm and 1½ hp at 1750 rpm. Pitch diameter is 5.93 in. Length of bore is 2¾ in. Lovejoy Flexible Coupling Co., 4856 W. Lake St., Chicago 44, Ill.

For more information—
Circle 104, inside back cover

Washers of Black Nylon

Five sizes, to fit screws from a No. 4 to a ¼ in., are carried in stock, and more sizes are in the planning stage. Outside diameters range from ⅜ to ⅛ in., and thicknesses from 0.020 to 0.040 in. Weckesser Co., 5701 Northwest Highway, Chicago 30, Ill.

For more information—
Circle 105, inside back cover

Heavy-Duty, Cam-Operated Indexing Unit

Positioning between automatic production stations or a simplified means of timing production operation drives is provided. Input is either ¾ or 3 hp, depending upon production per hour. Worm reduction can be supplied 10:1, 20:1, or 40:1. Increments of either 8, 12, 16 or 20 can be obtained during one complete cycle or revolution of the index table. Positioning for such operations as milling, grinding, drilling, threading, soldering, crimping or assembly is provided at each index position.

Worm and gear connections to the input shaft drive the cylindrical cam which in turn provides motion to the indexing table. All rotating shafts are mounted on tapered roller bearings. Cam shaft extensions provide a means for operation of auxiliary

(Continued on page 340)

Tapered for positive suspension.
High radial sealing surface.
"Tongue and groove" for easy installation.
Clearance for radial motion.

KOPPERS HUHN CARBON RING

Reduces Steam Loss as much as 90%!

The unique design of Koppers Huhn Carbon Ring reduces steam loss far below the customary 1% loss of labyrinths and carbon garter spring rings. Huhn Carbon Ring keeps steam loss as low as ¼ of 1% . . . often as little as 1/10 of 1%. Using your own figures for steam costs, you can easily discover how much Koppers Huhn Carbon Rings can save you annually.

The design assures you continuous radial sealing . . . because a radial sealing surface is always forced against a chamber wall. Automatic suspension . . . even during shutdowns . . . prevents shaft contact, reduces wear, and prolongs life. The Huhn Carbon Ring operates with peak efficiency at highest shaft surface speeds and highest operating temperatures.

Koppers Huhn Carbon Ring replaces labyrinths and carbon garter spring rings in compressors, and steam and water turbines. Steam savings alone often pay within a year for the cost of replacement. Discover now how Huhn Carbon Rings reduce steam and fluid losses and minimize operating, maintenance and repair costs. Write: KOPPERS COMPANY, INC., *Piston Ring and Seal Dept.*, 7304 Hamburg St., Baltimore 3, Md.

Koppers Company, Inc.
Metal Products Division
Piston Ring and Seal Dept.

***Engineered* Products**
Sold with *Service*

KOPPERS®

MECHANICAL SHAFT SEALS

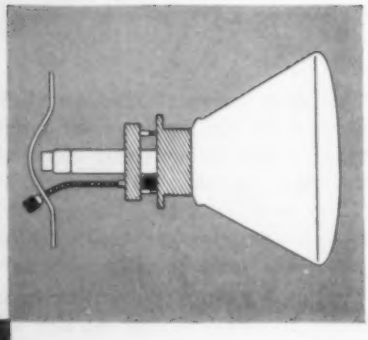
S. S. White

Flexible Shafts Make Operations Easier!

The manufacturer of this hue control for a color TV set uses a standard S.S. WHITE FLEXIBLE SHAFT to cope with a 90° turn. The shaft needs no alignment... can be quickly and easily installed. Costs are lower... manufacturing is simpler... assembly operations are easier, faster.

You can often reduce a complex system of gearing, universals and other parts to ONE FLEXIBLE SHAFT! Flexible shafts also make better designs possible . . . allowing new freedom in locating connected members to save space and facilitate operation and servicing.

For many years, these versatile shafts have been making industrial operations easier. They are tough and rugged... yet have the sensitivity you need for delicate adjustments. Design engineers and manufacturers discover new uses for S.S. WHITE FLEXIBLE SHAFTS every day. Can your product be improved by a simple... better . . . less costly way of transmitting power or remote control? Our engineers will be glad to work out a flexible shaft application with you. Just write to

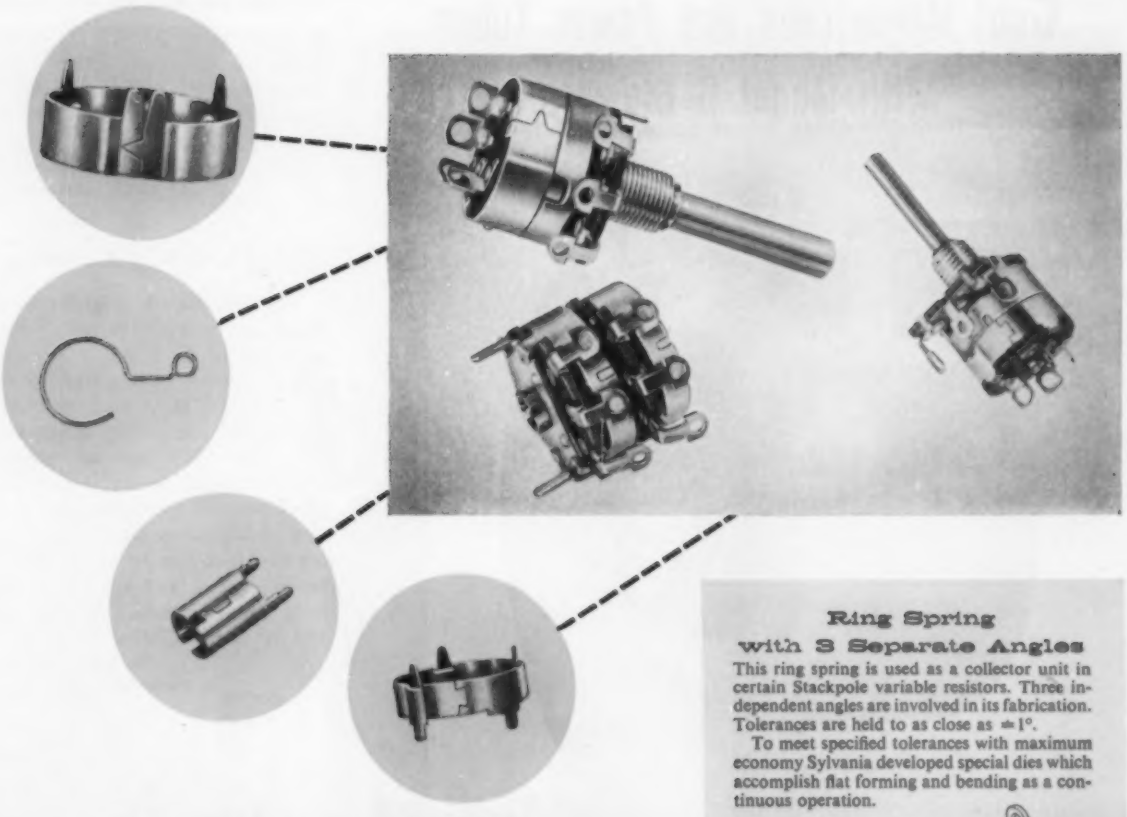


S. S. White

FIRST NAME IN FLEXIBLE SHAFTS

USEFUL DATA on how to select and apply flexible shafts. Write for Bulletin 5601.

S. S. White Industrial Division, Dept. D, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.



Formed metal parts

from Sylvania help assure inherent quality of STACKPOLE variable resistors

Stackpole designs and manufactures components to meet high standards of quality in electrical-electronic products.

For precision and uniformity in the volume production of critical metal parts used in variable resistors, the Stackpole Carbon Company relies on Sylvania's Parts Division.

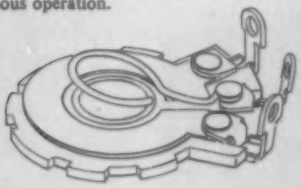
Many leading manufacturers, large and small, use Sylvania's 4-way service for high volume production of close tolerance parts. Let us submit a quotation on your specifications calling for custom-molded plastic parts . . . plated or clad specialty wire . . . electronic components . . . or formed metal parts.

For information on our facilities write for free copy of: "Portfolio of 4-way Service to Designers."

Ring Spring with 3 Separate Angles

This ring spring is used as a collector unit in certain Stackpole variable resistors. Three independent angles are involved in its fabrication. Tolerances are held to as close as ±1°.

To meet specified tolerances with maximum economy Sylvania developed special dies which accomplish flat forming and bending as a continuous operation.



Formed Switch Covers and Shaft

These are typical metal stampings used in certain Stackpole variable resistors. Sylvania's experience and know-how in fabricating small parts result in high volume production at low costs. Hollow shaft is carefully formed to hold diameter within ±.0025". Dovetail on large cover was designed by Sylvania to avoid nestling and tangling of parts during handling.

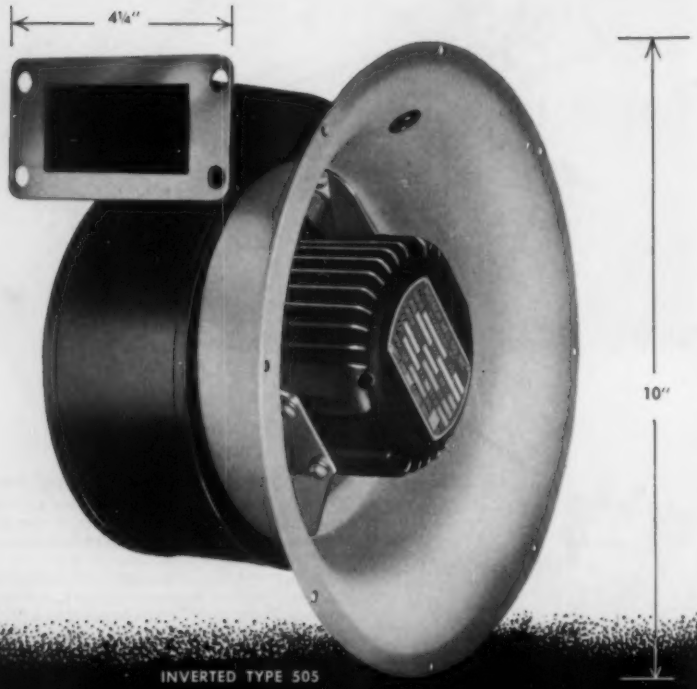
SYLVANIA PARTS DIVISION

Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

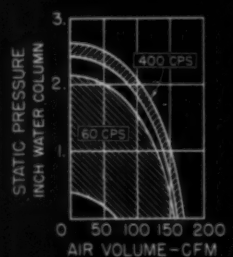
LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

SPECIAL WIRE | METAL STAMPINGS | MOLDED PLASTIC | ELECTRONIC COMPONENTS | 4-way service from one source

Cool Magnetrons and Power Tubes with Model D Blowers



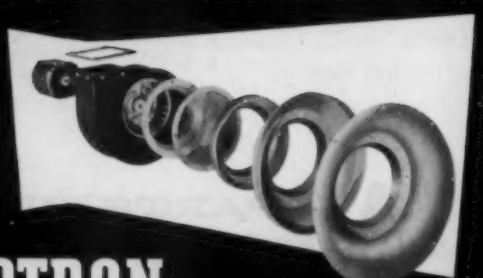
INVERTED TYPE 505



Shown is one of a family of high-pressure blowers designed for turbulent cooling in Commercial and Military Electronic applications where space is at a premium and long trouble-free life is mandatory.

OPTIONAL AIR INLET & OUTLET ADAPTORS & MOUNTING SURFACES

SEE Catalog Sheets:
40102-31
40102-32
30102-3



ROTRON MANUFACTURING CO., INC.
WOODSTOCK • NEW YORK

drives or other production devices. Dimensions: 27 x 26 x 21¾ in. high overall. Standard Tool & Mfg. Co., 237 Laurel Ave., Kearney, N. J.

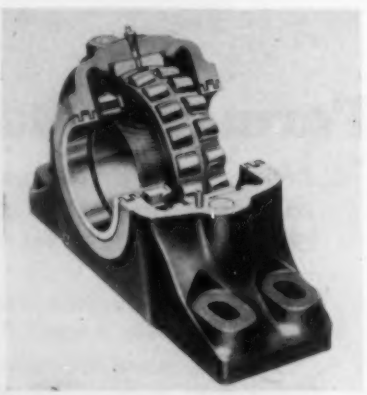
For more information—
Circle 106, inside back cover

Light-Duty Slip Coupling

The coupling has metallic friction plates and is available with bore dimensions of ½, ⅝ and ¾ in. dia in either member. The physical dimensions are 2⅜ x 1⅞ in. total shaft length.

Available with a disc spring assembly, Type 323 has an adjustable torque range up to 9 ft-lb max. Type 323A uses coil springs to provide friction plate pressure (the size and number of which can be varied) and can be adjusted to suit any torque range from 0 to 7.3 ft-lb. Hilliard Corp., 100 W. 4 St., Elmira, N. Y.

For more information—
Circle 107, inside back cover



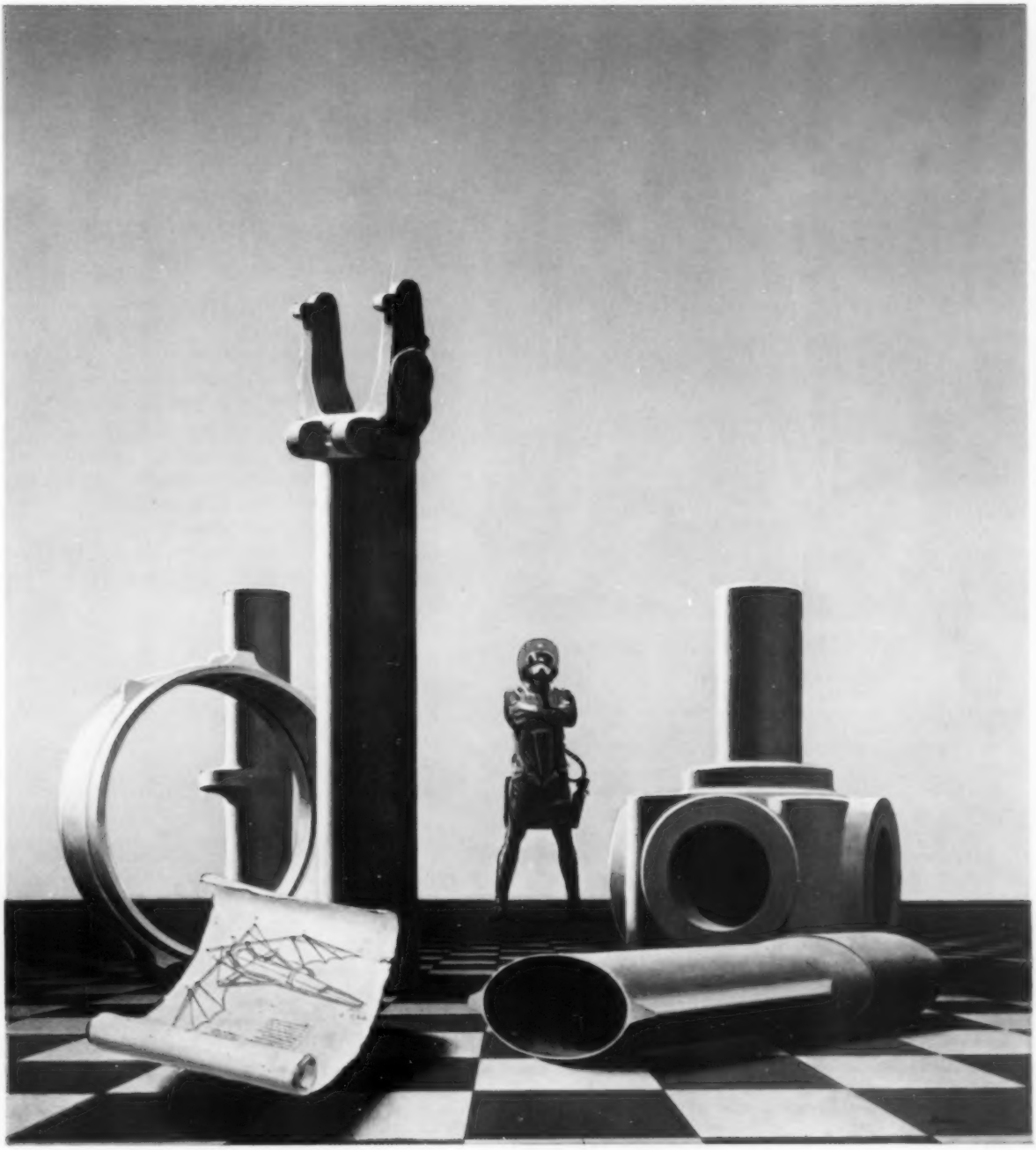
Spherical Roller Bearing Pillow Blocks

Seating of the bearings in these pillow blocks on shafts is accomplished with set screws located parallel to the bore in the adapter nut. After the bearing is snugged up, adjustment is completed by turning screws against the locking washer until bearing, adapter and shaft form an integral unit.

These pillow blocks are suggested for applications where self-alignment and ease of installation and maintenance are desirable.

Housing is of close-grained semi-steel. Lubricant enters at the center of the bearing and moves outwardly

(Continued on page 343)



Sky Steel

Aircraft design today is a challenge unequalled in any period of the past. The exacting requirements to produce a superior result have pushed metallurgy and metal working beyond traditional practice.

The designer less often selects from standards but rather proposes new shapes and new materials to produce results beyond traditional thinking.

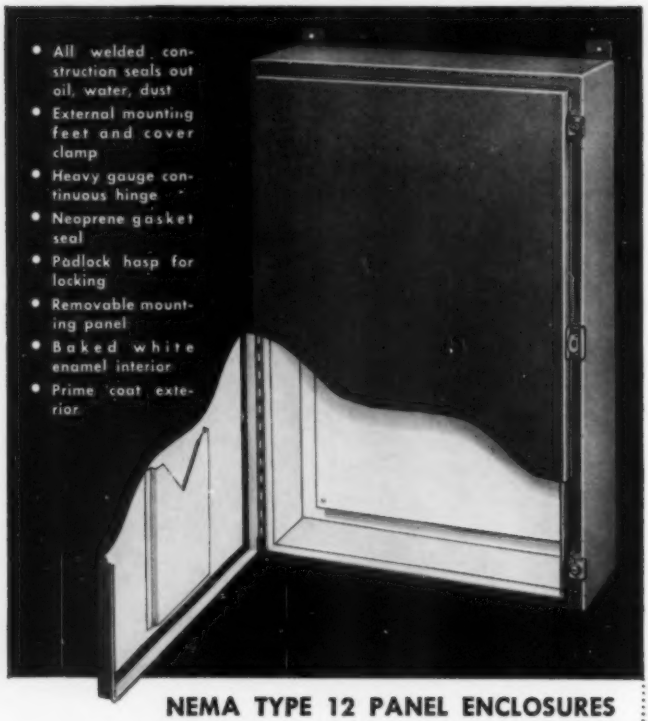
Cameron's contribution to this era has been the development of an unusual forging process for large, intricate ferrous components. Elimination of welds, better grain structure, internal as well as external curvatures, and considerable machining economy are making these remarkable "Sky Steel" forgings more popular every month. For complete information write or call . . .

Cameron
IRON WORKS, Inc.
P. O. Box 1212, Houston, Texas
SPECIAL PRODUCTS DEPARTMENT

OUR LIST OF CUSTOMERS INCLUDES: BENDIX PRODUCTS DIVISION, BENDIX AVIATION CORPORATION • CLEVELAND PNEUMATIC TOOL COMPANY • CURTISS-WRIGHT CORPORATION • FORD MOTOR COMPANY, AIRCRAFT ENGINE DIVISION • GENERAL ELECTRIC COMPANY, AIRCRAFT GAS TURBINE DIVISION • HAMILTON STANDARD DIVISION, UNITED AIRCRAFT CORPORATION • I-T-E CIRCUIT BREAKER COMPANY • H. W. LOUD MACHINE WORKS, INC. • PRATT AND WHITNEY AIRCRAFT • RHEEM MANUFACTURING COMPANY • RYAN AERONAUTICAL COMPANY • SOLAR AIRCRAFT COMPANY • THOMPSON PRODUCTS, INC. • WESTINGHOUSE ELECTRIC CORPORATION, AVIATION GAS TURBINE DIVISION

Which of these oil-proof enclosures can you use right now?

Write us


• All welded construction seals out oil, water, dust
• External mounting feet and cover clamp
• Heavy gauge continuous hinge
• Neoprene gasket seal
• Padlock hasp for locking
• Removable mounting panel
• Baked white enamel interior
• Prime coat exterior

WE SPECIALIZE IN HIGH QUALITY SHEET METAL ENCLOSURES OF ADVANCED DESIGN

Here are some of the Hoffman boxes that the trade likes so well today. We build them strong and give them a smart, clean finish. Customers like them so well we've had to double and then redouble our production space. Why not look at a sample? You'll see why.

All of these models comply with J. I. C. specifications and come in a wide range of sizes. They are stocked by selected electrical wholesale distributors—fast service. But we can make any special size you need to fit your specifications. Tell us your problem—we can work it out.

NEMA TYPE 12 PANEL ENCLOSURES

These panel enclosures are strong, rigid and cleanly finished. All welded construction on heavy gauge steel. No knockouts or holes to admit oil, water, dust. Stock sizes at low cost for fast delivery. Or we can make any size you want. Illustrated above is wall cabinet type. We also make a *floor mounted 2-door series* in the following sizes: 54x42x8, 60x48x8, 60x48x10, 60x60x10, 72x60x10.

STANDARD STOCK SIZES, SINGLE DOOR, WALL MOUNTED

16 x 12 x 6	30 x 20 x 6	30 x 24 x 8	42 x 36 x 8
20 x 16 x 6	30 x 24 x 6	36 x 24 x 8	48 x 30 x 8
20 x 20 x 6	36 x 24 x 6	36 x 30 x 8	48 x 36 x 8
24 x 20 x 6	24 x 24 x 8	42 x 30 x 8	60 x 36 x 8

Need a little one like this?

2" WIRING BOXES

This is a unique small box which may be just what you are looking for. Completely oil-tight and dust-proof. Neoprene gasketed cover. Cover screws thread into the box outside the gasket line. Available with or without mounting feet. Stock size 4 x 2 x 2, or other sizes on specification.

PUSHBUTTON BOXES

Patented openings will fit all standard makes of oil-tight units. Conduit connections can be made at any location you specify. Neoprene gasket provides positive cover seal. This type is made of 14 gauge steel, and is immediately available in ten standard sizes to accommodate from one to twenty-five push buttons. Cost is surprisingly low.

Improved
J. I. C. WIRING BOXES

Oil-proof
Dust-proof

4 x 4 x 3
6 x 4 x 3
6 x 6 x 4
8 x 6 x 3½
10 x 8 x 4
12 x 10 x 5
14 x 12 x 6
16 x 14 x 6

Fourteen gauge steel, welded seams, all sides flanged. Neoprene gasketed cover chained to box, clamps on tight, opens up easily. No screw holes to leak oil or water. Clamp screws captivated, cannot get lost. Available with or without removable panel. Eight standard sizes.

J. I. C. WIRING TROUGHS

Ideal for electrical wiring on machinery, in buildings, and outdoors where oil, dust, dirt or water is a problem. All seams welded, no holes in trough or cover. Gasketed clamp cover provides tight seal. Eight standard sizes ranging from 2½ x 2½ x 12 to 4 x 4 x 72. Special sizes on request.

***Note:** These troughs are also available with flanged ends and fittings that can be bolted together to make a continuous oil-tight wireway.*

Hoffman ENGINEERING CORPORATION
Dept. PE-63, Anoka, Minn. Phone Harrison 1-2240

along all bearing surfaces. Drain plugs permit use of either grease or oil and provide for flushing. Triple seals retain the lubricant.

Dimensions of the pillow blocks are standardized, making them interchangeable with similar units. These bearings are stocked in both expansion and non-expansion types, in sizes to fit shafts from 2 7/16 to 8 in. dia. Dodge Mfg. Corp., Mishawaka, Ind.

For more information—
Circle 108, inside back cover

Roll-Over Printer

The printer is custom-made to fit into a production machine or line, permanently marking free-rolling products as they are guided over the inked marking die. The weight of the rolling product, as it approaches the printer, trips the printing unit mechanism to ink and position the marking die. As the product rolls over the inked die, it is imprinted. Either longitudinal or peripheral marking can be provided. Pannier Corp., 513 Sandusky St., Pittsburgh 12, Pa.

For more information—
Circle 109, inside back cover

Double and Triple-Reduction Speed Reducers

Double and triple-reduction speed reducers have ratings up to 50 hp and efficiency ranges of 97% or better. Western Gear Corp., P. O. Box 182, Lynwood, Calif.

For more information—
Circle 110, inside back cover

Metal-To-Metal Seal in Hydraulic Fitting

Where several hydraulic lines must be concentrated, this fitting is said to make possible the setting of high pressure hydraulic fittings side-by-side on subpanels. For example, the user can put two ¼ in. fittings side-by-side with 1 in. or less center-to-center spacing, using straights, ells and tees. Attaching and removing the fitting is achieved with ordinary tools, regardless of shape or style, since no swing radius is required. No special finish on the sealing seat is required.

The body of the fitting remains

(Continued on page 346)

WHY MOTORPUMPS SHOULD BE YOUR

First choice...

Built by Ingersoll-Rand, the world's largest manufacturer of centrifugal pumps . . . a company with unsurpassed design, metallurgical, test and manufacturing facilities . . . to give you:

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- operating dependability and efficiency
- mounting versatility—immersion, sidewall or foot type
- unusually low maintenance cost
- heavy duty construction
- best in brand name motors

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Only your *imagination*

limits the ways you can use Ampco Alloys

That . . . and the requirements of the part you're designing

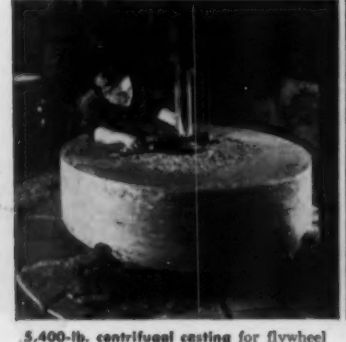
Should your part be sand-cast, centrifugally cast, shell-molded, precision-cast, forged, fabricated or extruded?

Let an Ampco field engineer help you to select the best, most economical form of production. It's all part of Ampco's one-source service to industry.

And he can help you select the best alloy, too. For among more than 100 Ampco copper-base alloys is the one you need to do the job — to resist wear, corrosion, impact, fatigue — to provide excellent bearing qualities — to retain physical characteristics at temperatures from 600°F down to −400°F.

So call in your Ampco field engineer and get his unbiased recommendations.

Write for Bulletin 33. D-83



5,400-lb. centrifugal casting for flywheel of a marine engine. Ampco makes centrifugal castings from a few pounds to five tons.

12,000-lb. sand-cast water wheel. Ampco's sand foundry makes any-size casting to 14,000 pounds — sand, shell moldings, cast-to-size, cement.

Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the exacting quality standards of the aircraft industry.

AMPCO METAL, INC. Dept. PE-4, Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California

AMPCO **THE METAL WITHOUT AN EQUAL**

SAND CASTINGS

SHELL-MOLDED CASTINGS

CENTRIFUGAL CASTINGS

EXTRUSIONS

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SHEET AND PLATE

CAST-TO-SIZE CASTINGS

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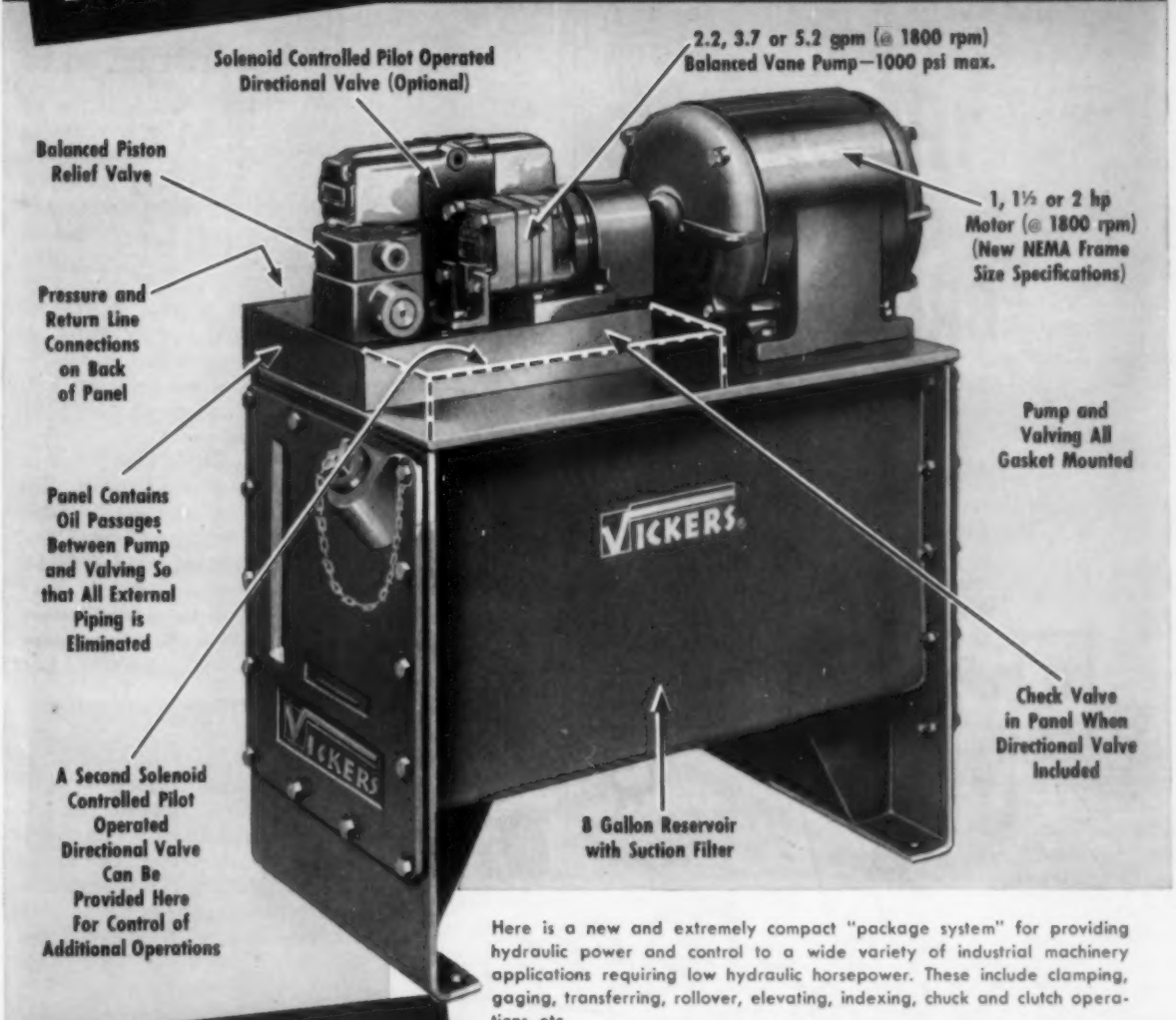
A NEW IDEA . . . in hydraulic power and control systems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2.2, 3.7 or 5.2 gpm (@ 1800 rpm) Balanced Vane Pump—1000 psi max.
Balanced Piston Relief Valve
1, 1½ or 2 hp Motor (@ 1800 rpm) (New NEMA Frame Size Specifications)
Pressure and Return Line Connections on Back of Panel
Pump and Valving All Gasket Mounted
Panel Contains Oil Passages Between Pump and Valving So that All External Piping is Eliminated
VICKERS
Check Valve in Panel When Directional Valve Included
A Second Solenoid Controlled Pilot Operated Directional Valve Can Be Provided Here For Control of Additional Operations
8 Gallon Reservoir with Suction Filter

VICKERS®

Series T8

HYDRAULIC

PIPELESS

POWER PACKAGE*

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Here is a new and extremely compact "package system" for providing hydraulic power and control to a wide variety of industrial machinery applications requiring low hydraulic horsepower. These include clamping, gaging, transferring, rollover, elevating, indexing, chuck and clutch operations, etc.

Note the many features indicated on the photograph above. The result is improved and simplified hydraulic design . . . also reduced installation and maintenance costs. This "package system" has great flexibility . . . is available in a wide variety of combinations of standard components assembled to suit individual requirements. Pretested and ready for immediate operation, it has also the advantage of undivided Vickers responsibility. For further information, ask for installation drawings 178706-8.

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DIVISION OF SPERRY RAND CORPORATION
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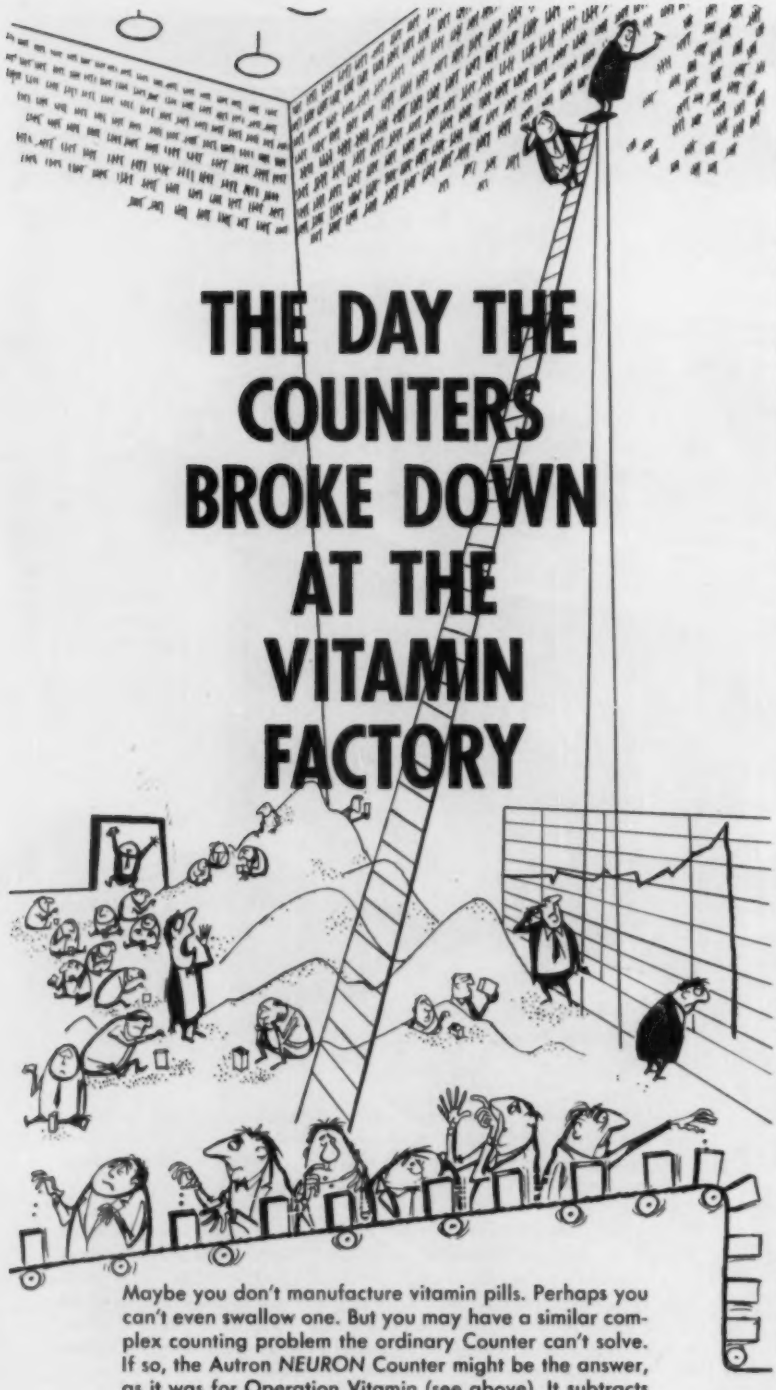
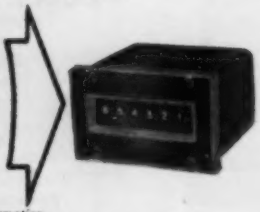
*These "package systems" supplement the Vickers line of standard hydraulic power units.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



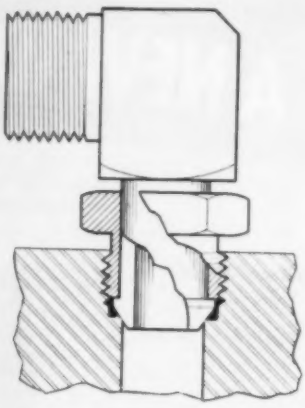
Maybe you don't manufacture vitamin pills. Perhaps you can't even swallow one. But you may have a similar complex counting problem the ordinary Counter can't solve. If so, the Autron *NEURON* Counter might be the answer, as it was for Operation Vitamin (see above). It subtracts as well as adds (see below).

The "NEURON" counters epitomize the most advanced electro-magnetic counter technology, featuring high speed (to 60 PPS), long life (in excess of 300 million cycles), pulse reset, switch readout, bi-directional drive (add and subtract), and small size. These precision units may well be the answer to your tabulation problems.



Autron
ENGINEERING, INC.

For further information, write to Paul Engle 1284 WEST SIXTH STREET LOS ANGELES 17, CALIF.
Offices in major cities



stationary, due to the captive nut which floats on a stem above its threads. This construction permits the nut to be lowered and tightened, forcing the fitting seal against a machined step and coining a seat.

The seal is available from ¼ to 2 in. OD, in all conventional shapes. The unit is made in self-flaring, no-flare and flare-type fittings. Flodar Corp., 16911 St. Clair Ave., Cleveland 10, Ohio

For more information—
Circle 111, inside back cover

Vibratory Feeder

Trough size of this feeder is 1½ x 12 in. and feed rate capacity is up to 500 lb per hr of bulk material. The electromagnetic vibrating principle is employed. Control of rate of material flow is by a rheostat in a separate controller. The rate of feed can be regulated from trickle to a full flow. Operation is on a 115 v, 60 cps, a-c line. Syntron Co., 240 Lexington Ave., Homer City, Pa.

For more information—
Circle 112, inside back cover

ENGINEERING DEPT. EQUIPMENT

Adjustable Scale-Drafter

Made of acrylic plastic, this drafting instrument can be used with a T-square or straight-edge. Two beveled flat scales are attached to a swivel quadrant. The quadrant rotates on a base form with protractor graduated on a shaped oval guide. Graduated 10 to 90 deg, engraved center line and markings permit exact vernier

(Continued on page 350)

No. 2
of a series of ads dealing with basic facts about thermostatic metals.

Designing for Product Improvement With WILCO THERMOMETAL®

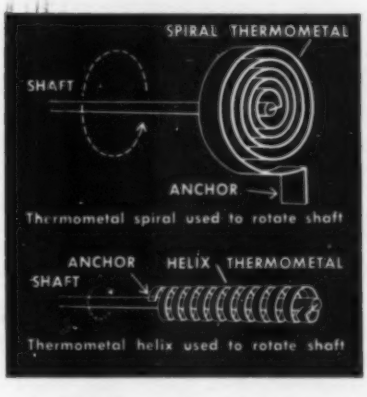
Thermometal in Thermometers

Thermometal is a composite material of two or more different metals with unequal coefficients of expansion. The difference in rate of expansion causes it to change shape with changes in temperature and, if restrained, to build up force.

This basic fact is of great industrial importance, for it makes possible the application of Thermometal in several broad categories. One of these is in *Temperature Indication*, as in Thermometal thermometers.

Thermometal offers five extremely important advantages in this type of application:

1. Thermometal lends itself to simplicity of design within the temperature range of −100°F to 1000°F. All that is required is an actuating thermometal element, a shaft to transmit motion, and a dial and pointer.

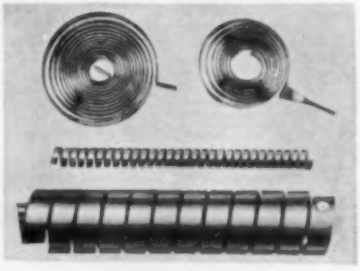


2. Its inherent strength and ruggedness enables it to resist considerable mechanical shock and vibration without suffering fracture or distortion.

3. It meets perfectly the specific needs of low cost, high volume production.

4. Thermometers made with Thermometal can be subjected to temperatures above and below their indicating temperature range without damage or loss of calibration.

5. Long mechanical linkages can be used between the source of heat and the temperature indicating dial. This permits easy reading of temperatures without having to remove the thermometer from the source of heat.



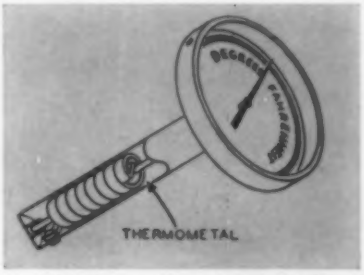
Basic shapes

Thermometal can be made to perform simple rotary motion. In temperature indicating devices, two basic shapes are used to produce this motion:

Spirals of varying diameters and widths; and helices of varying lengths and diameters.

The choice of shape is dictated by the design and application of the thermometer. In the flat type, a spiral is used.

In the stem type, a helix is used.



Selection of Thermometal

Four performance factors generally govern the selection of Thermometal for thermometers.

1. Temperature range over which indication is desired.

2. Maximum and minimum temperature to which the unit may be subjected.

3. Mechanical rigidity required to resist vibration and to overcome friction.

4. Space limitations within the thermometer.

The H. A. Wilson Company is the American pioneer in the development and manufacture of thermostatic metals. We produce over 40 metals for this use. Also we make a complete line of electrical contacts for use with Thermometal.

Reprints of this series are available on request. For further information about our products, ask for the Wilco Blue Book, the most complete reference manual ever written on Thermometal. And if you have any immediate application problem for Thermometal or other Wilco products, please tell us. Our engineering service is at your disposal.

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COMPOSITE METALS
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ENGELHARD INDUSTRIES

Now—Cleveland provides a single source for all your socket screw requirements

Simplifies specification, cuts paper work, speeds delivery

CLEVELAND STANDARD SOCKET SCREW PRODUCTS
UNIFIED THREADS—CLASS 3A FIT

Type	Standard Sizes (diam.)	Material
Socket head cap screws	#0 to 1½ in. (larger sizes avail.)	Alloy steel, heat treated or Nonmagnetic 18-8 stainless
Set screws (cup, half dog, flat, cone or oval points)	#0 to 1 in. (#0-#3, cup point only)	Alloy steel, heat treated or Nonmagnetic 18-8 stainless (to ½ in., cup point only)
Flat head socket cap screws	#4 to ¾ in.	Alloy steel heat treated
Button head socket cap screws	#4 to ⅝ in.	same
Shoulder screws (stripper bolts)	¼ to ¾ in.	same
Dowel pins	⅛ to 1 in. (nominal size and .001 in. oversize for repair)	same
Pressure plugs	⅛ to 1¼ in. NPTF	same
Socket screw keys	.028 to 1 in. across flats; short or long arm	same

Cleveland has expanded its socket screw line to provide a single source for all your socket head needs.

At the same time, and in conjunction with opening its new plant, Cleveland is doubling its factory warehousing capacity. This, plus the latest materials handling equipment, will enable Cleveland distributors to get same-day shipment of your larger orders.

Included in the expanded Cleveland socket screw line are precision dowel pins. While not a socket head product, they are basic fasteners for the important tool and die industry, where they are closely associated with socket head cap screws and shoulder screws. We offer them as part of a complete service.

Cleveland socket head cap screws are upset forged from heat-treated alloy steel. This results in symmetrical, unbroken grain structure in heads, threads and fillets—greater fatigue and tensile strength, stronger fasteners.

Write for latest literature and technical data. Then see your local Cleveland Cap Screw distributor for all your socket screw requirements.

THE CLEVELAND CAP SCREW COMPANY
4444-4 Lee Road, Cleveland 28, Ohio

LOCKING PIN AND PERIMETER DIMPLE
ZONE HARDENING
Engineering that stands out...
performance that stands up!
BALL RETAINER
LABYRINTH SEAL
SEALMASTER®
BALL BEARING UNITS
Here in the engineering department of SEALMASTER, many advanced features have been developed that have made SEALMASTER Ball Bearing Units the quality leader in the bearing field. These features not only provide a distinct advantage for SEALMASTER, they offer equal benefits for the original equipment manufacturers we serve.
Zone Hardening for example, means positive race to shaft holding power, a vital feature in today's high speed machinery. SEALMASTER'S land ridden ball retainer assures accurate spacing of balls, eliminating ball wear while equally distributing radial and thrust loads. A labyrinth seal consisting of felt-lined steel flingers rotating in labyrinth prevents entry of dust and dirt and retains proper amount of lubricant. SEALMASTER'S patented locking pin and perimeter dimple prevents rotation of outer race assuring positive lubrication while allowing for several degrees of misalignment.
Whether you design air conditioning equipment or road machinery; textile machines or farm equipment you'll want full information on these and other SEALMASTER features.
Write for Bulletin 454 for full information
SEALMASTER®
BALL BEARING UNITS
SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. 9 RIDGEWAY AVENUE, AURORA, ILL.

NO ONE FILTER MEETS ALL DESIGN NEEDS...

and Only CUNO offers you

5 DISTINCT TYPES OF FILTER MEDIA

♦ EDGE-TYPE ♦ WIRE-WOUND ♦ SCREEN
♦ FIBER CARTRIDGE
♦ POROUS METAL

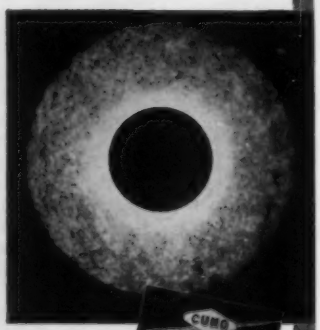
THE New WHITE CELLULOSE MICRO-KLEAN® FILTER CARTRIDGE

Where Filter Design Calls For—

5-MICRON FILTRATION . . . removes *all* particles down to this size *and* a large percentage of particles down to 1 micron or smaller.

COMPLETE SANITATION . . . for water, liquid food processing and other applications where *clarity, purity* and complete absence of any filter-imparted *taste* are essential.

EXCLUSIVE "GRADED DENSITY" construction makes entire depth of cartridge body available for micronic filtration . . . *doubles* cartridge life, cuts replacement costs *in half!*



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New DESIGN DATA . . . **MICRO-KLEAN FILTER** *combines fine filtration and high flow rates with important time- and space-saving advantages. Write now for your free copy of Catalog No. 53-100.*

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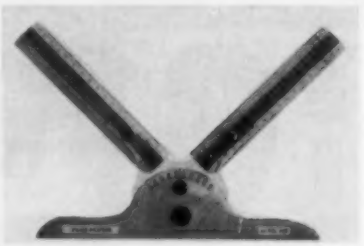

settings. Clamping screws lock in any desired setting.

Supplied with boxwood, white-edge, two bevel scales, unit can be ordered in 6 or 12 in. lengths with two scales as follows: architect's scales, $\frac{1}{8}$ to $\frac{1}{4}$ in. to the foot, and $\frac{1}{2}$ to 1 in. to the foot; engineers's scales, $\frac{1}{10}$ in. to the foot and 1/50 in. to the foot. Mechanical draftsman's scales are $\frac{1}{2}$ size, reading to 32nds, and full size reading to 16ths; or 50ths of inches and 32nds of inches. Alvin & Co., Windsor, Conn.

For more information—
Circle 113, inside back cover

Oscillograph for Multi-Channel Recording

Over-all dimensions are $4\frac{3}{4}$ x $1\frac{1}{4}$ x $3\frac{7}{8}$ in. high and it weighs $1\frac{1}{2}$ lb. The motor includes an integral mounting base which permits spacing of $1\frac{1}{4}$ in. on centers. A built-in micrometer setscrew makes possible accurate recording pen alignment to a common time axis; another setscrew is provided for pen zero adjustment.

The pen motor is direct-inking, with a disposable ink cartridge which is hermetically sealed to prevent evaporation and maintain correct ink viscosity at all times.

The frequency response with con-

(Continued on page 354)

Your forging problem is our business. Enthusiastic engineers at AmForge consider each project a new challenge —a challenge to *adapt* AmForge facilities and know-how to your problem. For example, the adjustment rack on a railroad switch stand above was once made as a casting. Although the design more readily adapted itself to casting methods, it was proved that it could be forged. The result was more uniformity, reduced machining hours and less scrap. Being stronger as a forging, the net weight of the part was reduced. Even the serrations are forged. Ask us for an AmForge Adaption Analysis. Phone, write or send the coupon at right.

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automatic control or positioning problem?

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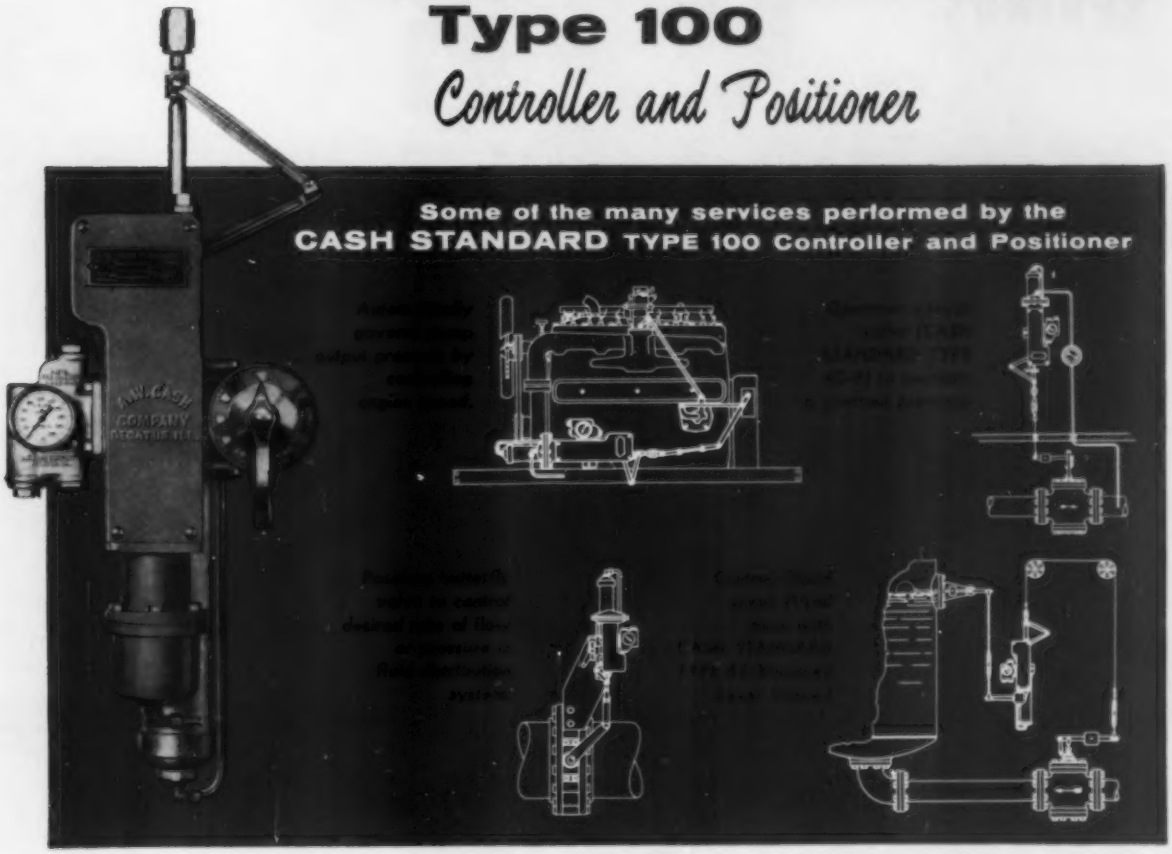
Type 100

Controller and Positioner



include this unit in your process system as:

1. A controller with self-contained positioning mechanism.
2. A power positioner actuated by a signal from another controller.

The Type 100 coupled with various types of final control elements will accurately control:
• Pressure • Liquid level • Rate of flow • Other process variables

The Type 100 features: • Feed back type control • Adjustable range • High sensitivity • Linear or curved line characteristics • Reverse or direct action • Optional manual control • Double acting cylinders, 6″ or 12″ stroke, 2″, 2¾″ or 4″ bore for operating pressures up to 125 psi. (Also suitable for larger cylinders in combination with volume booster when higher thrusts are desired.) • Operation by air, oil or clean water.

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WRITE TODAY for complete information, including literature, on this versatile instrument. Dept. J

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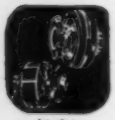
Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center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As many as 24 best quality springs are used in ROCKFORD Spring-Loaded CLUTCHES—to assure even pressure all around the plate. Made of heat-resistant wire (that will not take a "set") the springs, held in place by specially designed retainers and washers, provide long service life in today's high-speed engine driven vehicles.

Learn how this and other advantages of ROCKFORD CLUTCHES will improve the operation of *your* mobile products.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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ROCKFORD Clutch Division BORG-WARNER

209 Catherine St., Rockford, Ill., U.S.A.

Export Sales: Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

stant current input is flat from d-c to 60 cps, with a fall-off of 12 db/-octave from 60 to 200 cps. Sensitivity is 20 ma rms full scale. Massa Laboratories, Inc., 5 Fottler Road, Hingham, Mass.

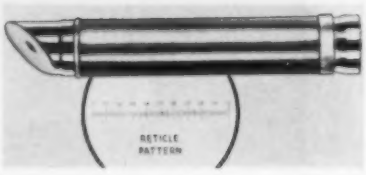
For more information—
Circle 114, inside back cover

High-Temperature Wire Kit

An evaluation kit containing 50 ft each of eight sizes and types of high temperature silicone rubber-insulated wire is designed for the use of those desiring an assortment of wire for evaluation. Temperature ratings are 150 and 200 C.

Wire sizes include No. 14, 18, 20, 22 and 24, all with stranded copper conductors, two sizes being silver plated, the others, tinned. Insulations include both 60 and 1000-v ratings. Three of the types have an outer glass braid, two have a Dacron braid and the rest are unbraided. The kit is contained in a compartmented transparent plastic box. Springfield Wire & Tinsel Co., P. O. Box 638, Springfield, Mass.

For more information—
Circle 115, inside back cover



Measuring Pocket Microscope

This 50x instrument contains an etched glass reticle calibrated for measurements up to $\frac{1}{10}$ in., by 0.001 in. divisions. Estimates to 0.0005 in. can easily be made. Chrome reflector at base of instrument reflects light on object examined or measured. Edmund Scientific Co., Barrington 23, N. J.

For more information—
Circle 116, inside back cover

Recording Oscillograph

Speed selection is from 0.5 to 80 ips, with a magazine capacity of 92 ft of recording paper and beam-type interrupter identification. Weight is

(Continued on page 358)

FLETCHER MINING EQUIPMENT REPORTS ON CHIKSAN SWIVEL JOINTS

LONG, SERVICE-FREE LIFE DESPITE EXTREME ABRASIVE DUST AND MECHANICAL ABUSE

When it comes to rugged service, the Fletcher Roof Drill really puts Chiksan Swivel Joints thru the paces. Installed on hydraulic lines where operating pressures run as high as 1800 psi, the Swivel Joints are used to minimize torque and eliminate knotting on lines as the bit is raised and turned. The Swivel Joints are subjected to extreme mechanical abuse and abrasive dust as the hard working drill bores a hole, then installs and tightens roof bolts in underground mines.

Yet with all of the extreme abuse and abrasive coating, the J. H. Fletcher Company reports Chiksan Swivel Joints continue to provide free swiveling action with exceptional maintenance-free service.

Assure yourself of this long-life, trouble-free service, by specifying versatile Chiksan Swivel Joints in your plant and equipment.

Chiksan Swivel Joints rotate 360° in 1, 2, and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

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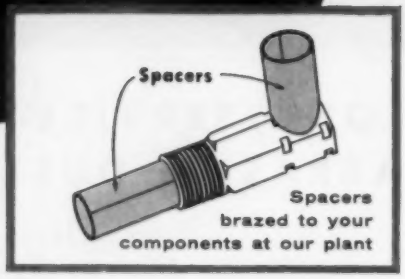

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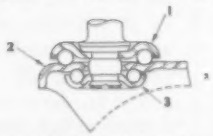

3. Lower ball race—accurately formed from heavy gauge steel, hardened, fully enclosed, dust-proof assembly.

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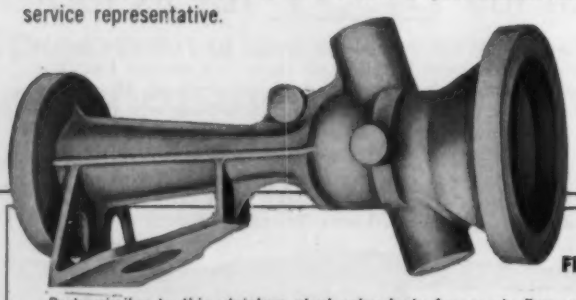

DESIGN FLEXIBILITY

Parts similar to this stainless steel valve body for an air flow controller often require several changes before design is finalized. Due to the relatively low cost of dies and die changes, the investment casting process has proven an inexpensive and flexible method.

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15½ lb; dimensions, 6$\frac{13}{16}$ x 5$\frac{7}{16}$ x 9$\frac{7}{16}$ in. Midwestern Instruments, 4100 Sheridan Road, Tulsa, Okla.

For more information—
Circle 117, inside back cover

Lettering Template Adds Latest Symbols

A revised lettering template, with latest symbols for draftsmen and engineers, conforms to recent changes in military and industrial standards. The new template contains a full capital alphabet and numerals with extra symbols for zone blocks, delta and surface roughness symbols, cutting plane arrowhead, and circles with marked quadrants for $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ in. dia. In addition, template corners are rounded to give $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. radius arcs of 90 deg. Material is aquamarine plastic, 0.065 in. thick. All of this template's drawing edges are tapered. E. F. Twomey Company, Inc., 728 W. 10 Pl., Los Angeles 15, Calif.

For more information—
Circle 118, inside back cover

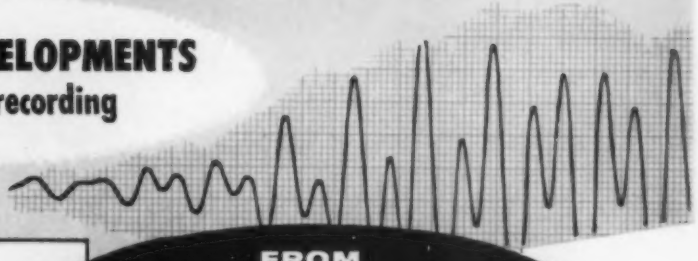
Grids for Perspective Drawing

Sets of seven grids are provided in three different sizes, for both interior and exterior rendering. The seven grids in any size are progressively displaced from each other in steps of 20°. Rotation of a basic set makes possible a total of 81 different positions in the representation of a subject. In addition to the grids themselves the basic sets include a selector chart for determining which grid and grid position to use for the viewing angle desired, plus an instruction book.

Size IX measures 11 x 11 in. and is accurate when seen from the normal reading distance of 18 in. Size 2X measures 22 x 22 in. and is accurate when seen from 36 in. or twice the normal reading distance. Size 4X measures 40 x 40 in. and is accurate when viewed at four times the normal reading distance, or 72 in. Each size provides grids for drawing either an exterior or interior view of the subject. Perspective, Inc., 402 American Building, Seattle 4, Wash.

For more information—
Circle 119, inside back cover

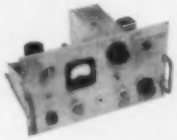
TECHNIQUES and DEVELOPMENTS
in oscillographic recording



FROM
SANBORN

PHASE SENSITIVE DEMODULATOR PREAMPLIFIER PROVIDES A DC VOLTAGE PROPORTIONAL TO AN INPHASE COMPONENT OF AN AC VOLTAGE WITH RESPECT TO A REFERENCE.

THE measurement of the amplitude of an AC voltage component is often necessary in performance studies of servo systems or of suppressed carrier signals over the carrier frequency range from 60 to 10,000 cps. In such cases the demodulator responds to inphase signals and rejects quadrature signals.



A circuit with these characteristics for use in an oscillographic recording system can be seen in the Model 150-1200 Servo Monitor (Demodulator) Preamplifier. It was developed by Sanborn as one of twelve interchangeable, plug-in front ends for "150" Series equipment, to be used with the appropriate Driver Amplifier-Power unit in any channel of a "150" system. Elements comprising the circuit from input to output, include: compensated stepped attenuator and cathode follower input circuit, phase inverter, push-pull mixer and demodulator stages, differential DC output amplifier and low pass filter. In addition, the chassis contains a VTVM to facilitate accurate adjustment of the reference voltage, and an overload indicator which lights a warning lamp when excessive quadrature voltages exist.

Adaptability to a fairly wide variety of applications is accomplished through broad input voltage, reference voltage and frequency ranges. In order, these are 50 mv to 50 v (for full scale 5 cm deflection), 10 v to 125 v; 60 cps to 10kc. Rise time with low frequency plug-in demodulation filter is 0.1 seconds; with high frequency filter, 0.01 seconds. Quadrature rejection is better than 100.1; for carrier frequencies up to 5000 cycles.

Two representative uses of the Servo Monitor Preamplifier are in the design and adjustment of servo systems, and with instruments used in the design, development or adjustment of other apparatus. The first is illustrated by use of the Preamplifier and associated equipment in the recording of the output shaft amplitude and driving frequency of an AC positional servo; the second by recordings made with a similar setup of the difference between output signals from a gyroscopically-controlled stabilizing device and the "pitch" and "roll" signals generated by a "Scorsby Table" used for testing the device under dynamic conditions.

For a detailed discussion of the principles and design considerations involved in the Servo Monitor Preamplifier, refer to the February, 1955 issue of the Sanborn RIGHT ANGLE, for Dr. Arthur Miller's article on "Measurements with the Servo Monitor Preamplifier."

Technical literature and engineering assistance on specific problems are always available from our engineering department.

BASIC FACTORS IN SELECTING OSCILLOGRAPHIC RECORDING EQUIPMENT

WHEN considering any oscillographic system or equipment for your application, three useful "yardsticks" to apply are (1) the recording method, (2) equipment adaptability, and (3) variety of equipment available. Here are the answers to the three, as they apply to Sanborn systems. In the record, rectangular coordinates accurately correlate multiple traces, simplify interpretation and eliminate errors. Permanent traces, produced by a hot ribbon stylus without ink, provide sharp peaks and notches, and clearly reveal all signal changes. One percent linearity results from current feedback driver amplifiers and high torque galvanometers of new design; maximum error is ¼ mm in middle 4 cm of chart, ½ mm across entire chart. From the standpoints of "adaptability" and "variety", Sanborn "150" equipment offers the versatility of 13 different plug-in front ends for any basic system . . . the choice of one- to eight-channel systems . . . the variety of nine chart speeds, timing and coding controls, console or individual unit packaging . . . availability of equipment as either complete systems or individual amplifier or recorder units.

The purpose of the foregoing information is to better acquaint industry with typical oscillographic recording problems and their answers, design considerations in Sanborn equipment, and basic data on what Sanborn makes and how it is being used.

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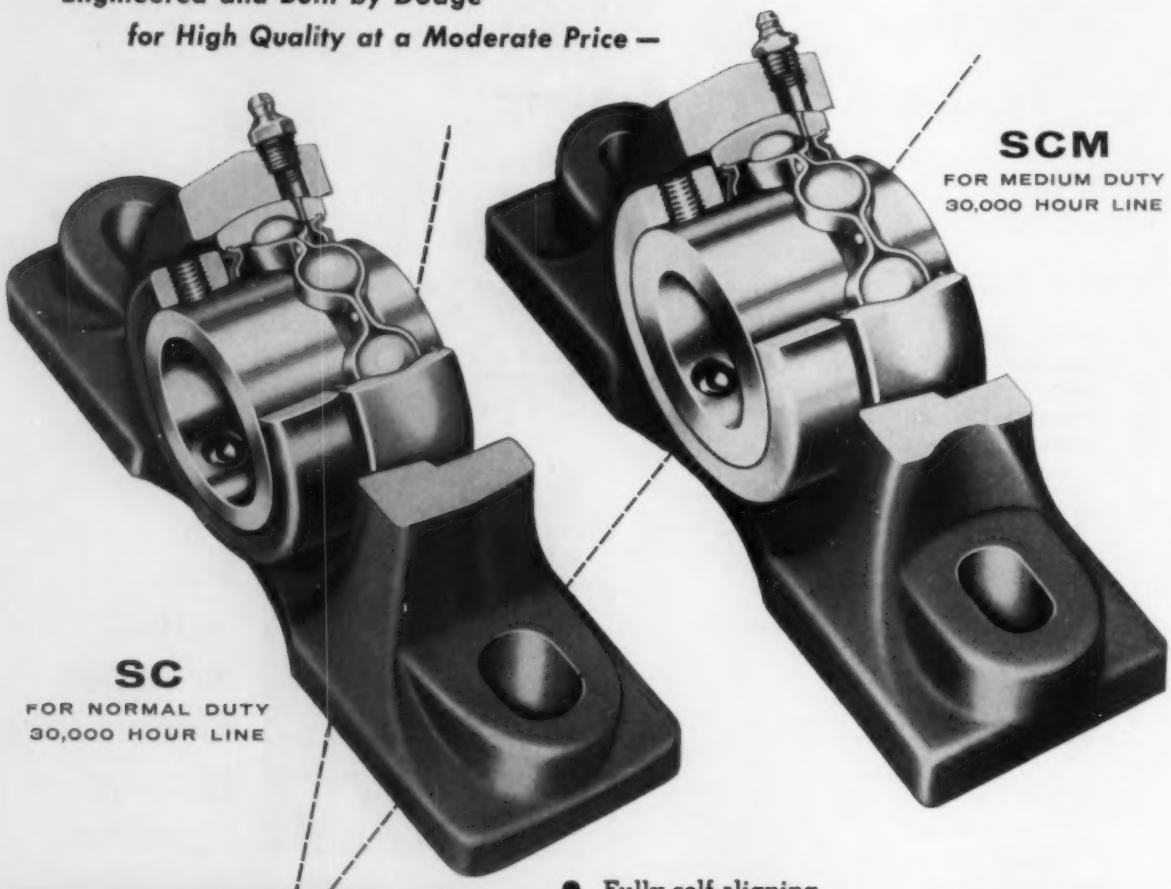

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 379.

Magnesium and Titanium–Booklet, 44 pp., of design data, including physical and mechanical properties, mechanical properties at elevated temperatures, metal weights, forming characteristics, specification tables, corrosion behavior, surface treatments, welding and joining, machining, heat treatment and stress relief. Strength-to-weight and stiffness-to-weight ratios for both metals are discussed. Brooks & Perkins, Inc., 1950 W. Fort St., Detroit 16, Mich.

Circle 120, inside back cover

Fabrication of Stainless Steels–Manual 590A, 40 pp. Describes cold forming methods, machining forging, heat treatment, finishing, passivation and includes table of physical, electrical, mechanical, thermal properties. Republic Steel Corp., 3100 E. 45 St., Cleveland 27, Ohio.

Circle 121, inside back cover

Corrosion Resistance of Chromallized Iron and Steel Parts–Bulletin, 8 pp. Contains results of corrosion tests run on various steels. Chromalloy Corp., 450 Tarrytown Road, White Plains, N. Y.

Circle 122, inside back cover

Aluminum Alloy Check Valve–Data sheet, 1 pp. Describes ¼ in. valves for 3000 psi service. Aircraft Products Co., 300 Church Road, Bridgeport, Pa.

Circle 123, inside back cover

Heavy-Duty Engines–Brochure, 4 pp. Contains data and diagrams of air-cooled units from 2.3 to 36 hp. Wisconsin Motor Corp., Milwaukee 46, Wis.

Circle 124, inside back cover

Hydraulic Hose Assemblies and Fittings–Bulletin 57S, 12 pp. Contains diagrams and data on couplings. Anchor Coupling Co., Inc., Libertyville, Ill.

Circle 125, inside back cover

Hydraulic Tube Fittings and Adapters–Bulletin 500, 12 pp. Contains diagrams and data on adapter unions, elbows, O-rings and locknuts. Eastman Mfg. Co., Manitowoc, Wis.

Circle 126, inside back cover

Electric Motor Selector–Booklet, 12 pp. Contains data on selection of motors from 1/20 to 400 hp. Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

Circle 127, inside back cover

Ball Bearing Components for Screw Conveyors–Folder 2489, 6 pp. Contains data on conveyor screws, trough ends and hangers. Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

Circle 128, inside back cover

Liquid Filters–Bulletin, 16 pp. Contains data on metal filters for full-flow filtration of lubricating, hydraulic or fuel oils. Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio.

Circle 129, inside back cover

Precision Stock Gears–Catalog, 88 pp. Contains data and price list of spur gears, bevel gears, slip clutches, clamps and collars. Dynamic Gear Co. Inc., Amityville, N. Y.

Circle 130, inside back cover

Miniature Ball and Roller Bearings–Catalog, 16 pp. Contains data on tolerance standards, internal clearances, load capacity calculations, speed limitations, and mounting. Landis & Gyr, Inc., 45 W. 45 St., New York 36, N. Y.

Circle 131, inside back cover

Bronze Valves–Bulletin DH-25, 4 pp. Describes solder-end and silver braze-end units in gate, globe and check designs. American Chain & Cable Co., Inc., Reading, Pa.

Circle 132, inside back cover

Gear Boxes, Actuators and Pressure Switches–Brochure, 4 pp. Contains

(Continued on page 364)

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100% efficiency at full load!

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- Flexidyne Dry Fluid Drives and Couplings. Bulletin A-640-A.
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- Roller Bearings. Load ratings, dimensions, etc. Bulletin A-638.

Write for your copies.
DODGE MANUFACTURING CORPORATION
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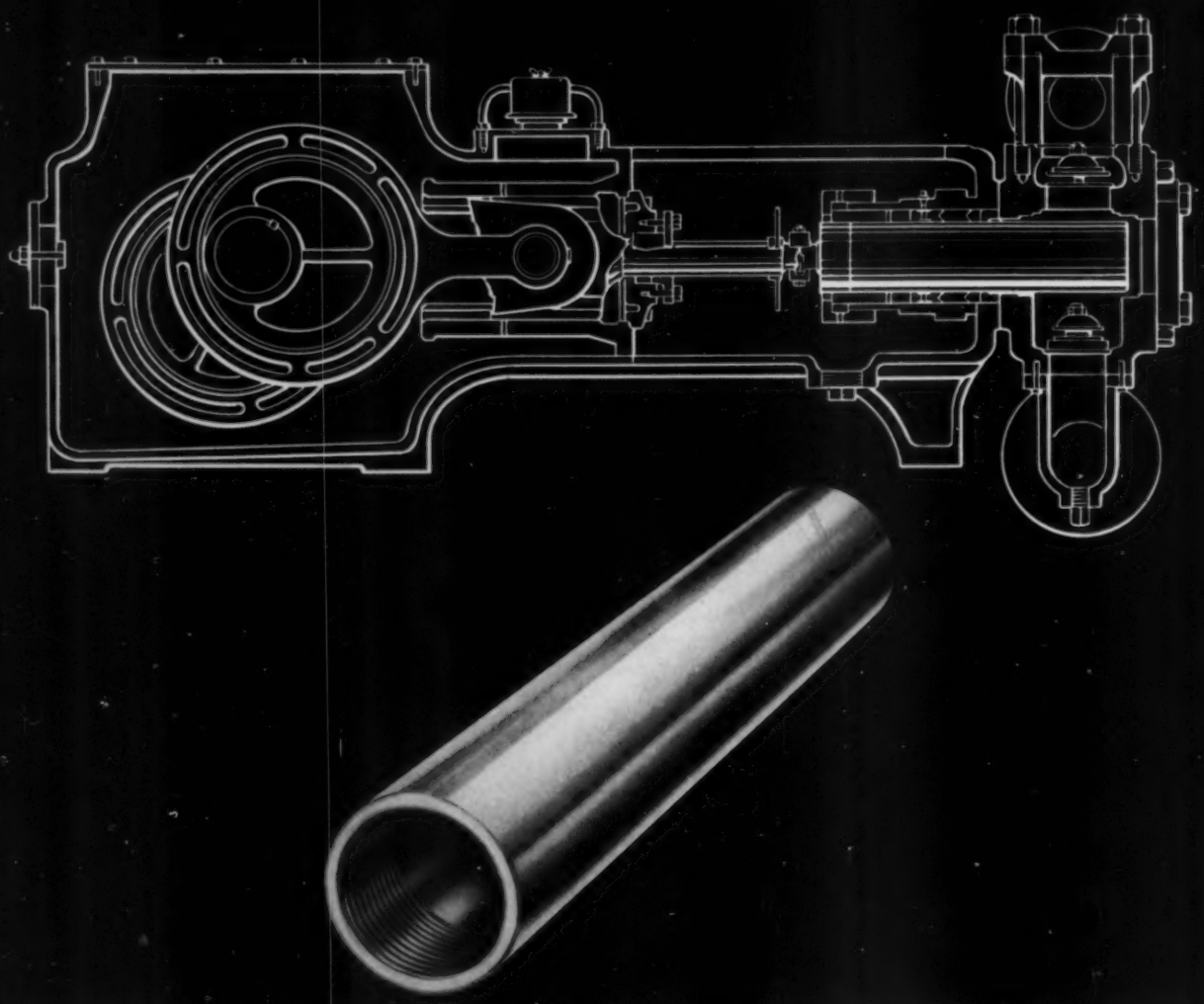

Reducing Costs With Job Matched Tubing

Does a higher grade tube really cost more? Reduced overall manufacturing cost of pump plungers resulted when one maker switched from tubing made from open hearth processed alloy steel to B&W electric-furnace Alloy Steel Tubing. Rejections on a large production run were reduced drastically (10.75% to 1.25%).

The plunger had to have a very good finish and was to be chrome plated. Jobs like this require high quality and "clean" steel. Because of B&W's melting practices and familiarity with making "clean" steels for bearings and other applications, it was suggested to the fabricator that he consider B&W electric-furnace 8620 Steel Tubing. The use of B&W electric-furnace Alloy Steel drastically reduced rejects on the finished part.

Once again Mr. Tubes proved conclusively that final cost—not initial cost—is the measure of good tube fabricating practice. If you're concerned with costs as well as producing a good finished product, get in touch with Mr. Tubes. He can help you save money. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6100-M5

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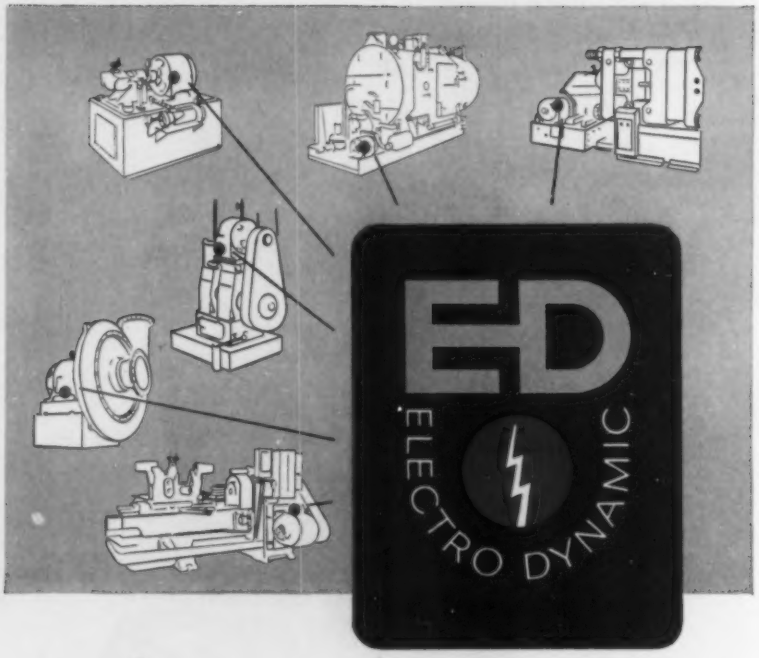

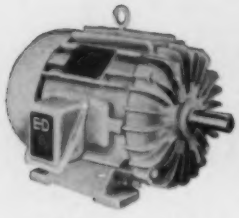

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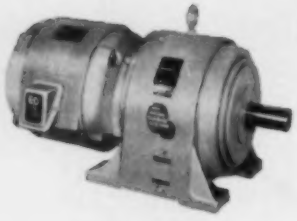

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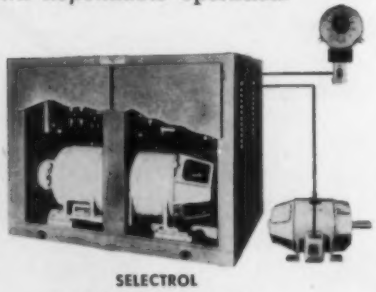

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data on miniaturized gear boxes, miniaturized vibration-resistant pressure switches, and lightweight, compact screwjack actuators. Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles, Calif.

Circle 133, inside back cover

Glass-Protected Steel–Brochure, 4 pp. Contains charts, tables and data on physical and chemical characteristics. A. O. Smith Corp., Milwaukee 1, Wis.

Circle 134, inside back cover

Revision of Plastic Pipe Standards–Booklet. This is a recommended revision of dimensions and tolerances for flexible standard-wall polyethylene pipe, Commercial Standard CS197-54. Commodity Standards Div., U. S. Dept. of Commerce, Washington 25, D. C.

Circle 135, inside back cover

Displacement Pumps–Bulletin 46601-B, 4 pp. Contains data on continuous pressure, constant displacement, heavy duty, fluid power units for systems from 3 to 10 hp., 3000 to 5000 psi. Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.

Circle 136, inside back cover

Stainless Steels–Booklet, 8 pp. Contains information on Types 308, 309 and 310 stainless, including information on physical properties, heat treatment, strength at elevated temperatures and fatigue strength. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

Circle 137, inside back cover

Conveyor Chains–Bulletin 56-60, 24 pp. Contains diagrams and data on steel and nylon chains. Chain Belt Co., Milwaukee 1, Wis.

Circle 138, inside back cover

Alloys for Machinery Parts–Booklet, 44 pp. Contains data on chemical, physical and mechanical properties, corrosion resistance, and machining of cobalt-base, nickel-base, and iron-base alloys. Haynes Stellite Co., 30-20 Thomson Ave., Long Island City 1, N. Y.

Circle 139, inside back cover

Servo Motors–Bulletin 385, 8 pp. Contains data and diagrams on custom and standard units. Norden-Ketay

(Continued on page 366)

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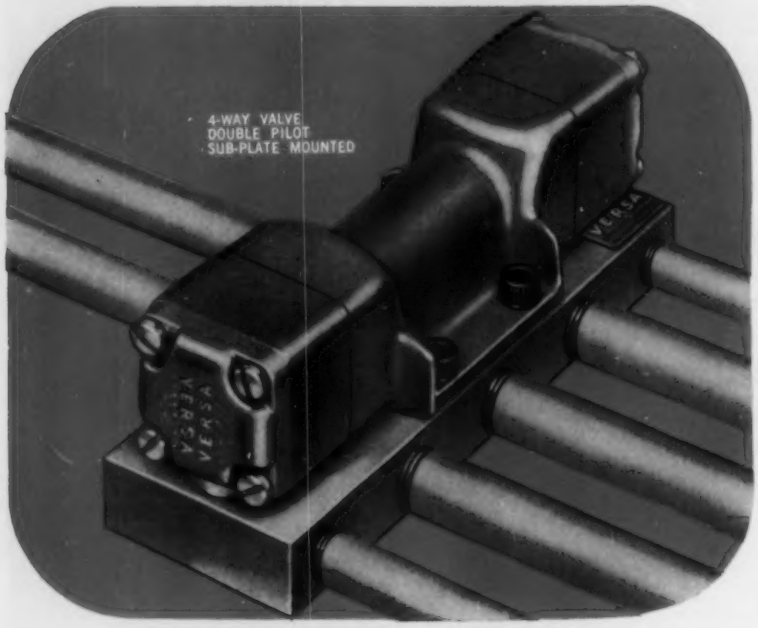
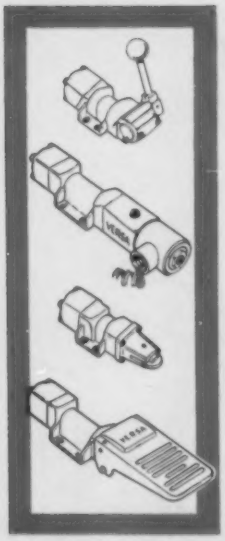


THE VERSA MANIFOLD MOUNT VALVE



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The entire line of VERSA valves is explained in our new comprehensive Folder #14

Catalogs and Bulletins.....continued

Corp., Commerce Road, Stamford, Conn.

Circle 140, inside back cover

Stainless Steels—Data sheets 285, 286, 7 pp. Contains data on Type 329 in tubular form, and Type 309S. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 141, inside back cover

Transformers—Catalog 571, 48 pp. Contains data and graphs on transformers (audio, power, pulse), filters and discriminators, toroids, magnetic amplifiers and ultrasonic components. Freed Transformer Co., Inc., 1752 Weirfield St., Brooklyn 27, N. Y.

Circle 142, inside back cover

Valves and Pumps—Bulletin H3A2, 16 pp. Details function and design of oil hydraulic pumps, tandem pump and motor-pump combinations and control valves. Webster Electric Co., 1900 Clark Ave., Racine, Wis.

Circle 143, inside back cover

Magnetic Multiple Disc Clutch—Bulletin 690, 8 pp. Contains diagrams and data on unit for auxiliary and feed drives of machine tools. McCauley Industrial Corp., 1840 Howell Ave., Dayton 7, Ohio.

Circle 144, inside back cover

Copper-Clad Laminated Plastics—Brochure, 4 pp. Contains information about rolled copper and its use on laminated plastics. Taylor Fibre Co., Norristown, Pa.

Circle 145, inside back cover

Electrical Insulation—Brochure, 4 pp. Contains charts and data on formed and fiber channel wedges. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 146, inside back cover

Impulse Counters and Transmitters—Bulletin, 8 pp. Gives properties of models designed for automatic recycling of counting runs, electrical data and connection diagrams. Landis & Gyr, Inc., 45 W. 45 St., New York 36, N. Y.

Circle 147, inside back cover

Molybdenum-disulfide—As a Filler—Bulletin, 4 pp. Describes the uses of molybdenum disulfide as a filler in nylon, phenolic laminates, Teflon and other plastics. Climax Molybdenum

(Continued on page 371)

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"Our Stainless Castings are Special"

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Write for this book on A-L STAINLESS STEEL CASTINGS

28 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

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And not just as a matter of meeting the service conditions, either. We're ready to handle any special shape or difficult-to-cast section your job may require . . . and any size of casting from a few ounces to several tons.

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SPECIAL REPORTS ON FINISHING NON-FERROUS METALS

NUMBER III—Lustrous, Corrosion-Resistant Finishing with Chemical Polishing Iridite

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are widely accepted throughout industry as an economical means of providing corrosion protection, a good base for paint and decorative finishes for non-ferrous metals. Certain of these coatings also possess chemical polishing abilities that have luster-producing, as well as corrosion-inhibiting, effects on zinc and cadmium plate, zinc die castings and copper alloys. However, continued developments in this field have been so rapid that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this discussion of the many ways in which this chemical polishing characteristic can be used in final finishing or pre-plating treatments to produce a lustrous appearance with distinct display and sales appeal and appreciable savings in cost. Report I on decorative, corrosion-resistant finishes and Report II on paint base corrosion-resistant finishes are available on request.

The degree of luster possible on a surface is a function of the degree to which the surface can be smoothed. Leveling to provide a smooth surface can be achieved by mechanical or chemical means, or a combination of these, depending upon the luster desired and the original condition of the metal. Chemical polishing effectively imparts luster otherwise difficult and costly to obtain. For this reason, it is often used to supplement or entirely replace mechanical polishing, depending upon the application and the original condition of the metal. Chemical polishing has the additional advantage of providing overall treatment of the submerged part. It reaches into even the deepest corners and recesses that are otherwise inaccessible. Certain of the Iridites are specifically designed to perform this chemical polishing operation. Also, they provide corrosion protection as do all Iridites, thus may be used as a final finish or a pre-plating polish.

If Iridite is to be used as a final finish, in contrast to pre-plating treatment, the chromate conversion coating generated is allowed to remain, providing good corrosion resistance. Color inherent in these Iridite films ranges from a yellow cast to yellow iridescent. These coatings may be used without further treatment where this color is acceptable and good corrosion resistance is desired. Further, these basic coatings can be tinted by dyeing. Among the dye tints available are shades of red, yellow, blue and green. If desirable, the basic coatings can also be modified by a bleach dip leaving a clear bright or blue iridescent finish. In all cases bleaching reduces corrosion resistance.

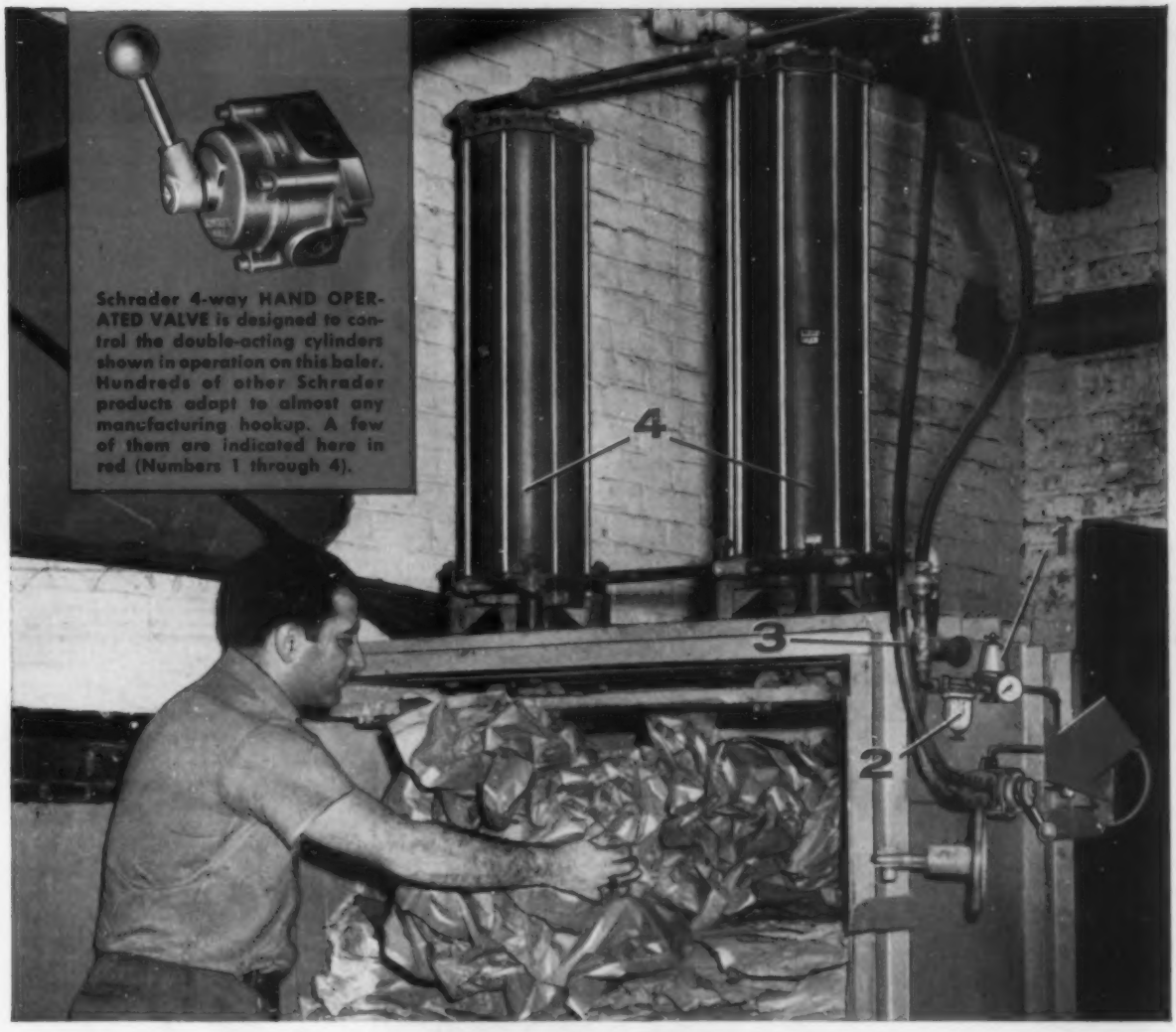
As examples of this type of final finishing, Iridites #4-73 and #4-75 (Cast-Zinc-Brite) make possible for the first time, lustrous chemical polishing of the as-cast surface of zinc die castings. Thus, in many cases, sizeable savings in finishing cost are realized by elimination of plating costs. This economical method can be used on tools, appliance parts, toy pistols, locks and many other small castings. Another example is the treatment of copper and brass parts, such as welding tips, to eliminate buffing and provide additional corrosion resistance. In many cases, handling costs are reduced appreciably by replacing piece-part handling with bulk processing. Still another example of the use of this chemical polishing and protective quality of Iridite is a simple system of zinc plate, Iridite and clear lacquer instead of more costly electroplated finishes. Typical of this type of lustrous finish are builders hardware and wire goods.

As a pre-plating treatment, in contrast to final finishes, Iridite can be used to chemically polish zinc die castings or copper prior to plating. In such cases, Iridite should be applied as an in-process step, so that the protective film is removed before the plating cycle. The savings in handling, material and labor costs are obvious. This process has made it practical to plate chrome directly over copper on steel, conserving nickel, yet producing a lustrous chrome finish. Used after stripping faulty plate in reprocessing zinc die castings, Iridite restores luster to the casting, thus making possible replating without blistering.

Other Iridite finishes are available to produce maximum corrosion resistance, a wide variety of decorative finishes and excellent bases for paint on all commercial forms of the more commonly used non-ferrous metals. As a final finish, appearance ranges from clear bright to olive drab and brown and many films can be bleached or dyed. As a paint base Iridite provides excellent initial and retentive paint adhesion and a self-healing property which protects bare metal if exposed by scratching. Iridites have low electrical resistance. Some can be soldered and welded. The Iridite film itself does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of their top performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product demands the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.


Schrader 4-way HAND OPERATED VALVE is designed to control the double-acting cylinders shown in operation on this baler. Hundreds of other Schrader products adapt to almost any manufacturing hookup. A few of them are indicated here in red (Numbers 1 through 4).
4
3
2
1

How Schrader Air Products bale paper, producing 4 ton pressure with 100 lbs. of air

At this Rhode Island dye works, the paper baling operation formerly was a fatiguing manual chore. Now, the operator simply fills the press with used paper and cartons, and pulls a 4-way hand valve. One hundred pounds of air pressure flowing through the two Schrader double-acting cylinders then compress the paper with four tons of force. Finger-tip adjustments can reduce or raise pressure quickly, easily.

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1. It combines the strength advantages of machined bar stock aluminum with the shock-resistant qualities of a resilient insert.
2. A modified, double stub thread provides for speed and convenience in mating and disconnecting and the special tapered cross-section thread design resists loosening under vibration. The threads can be easily hand cleaned if contaminated by a substance such as mud or sand.
3. An Alumilite 225 hard anodic finish is used which gives a case hardening to the aluminum surface. This finish offers outstanding resistance to corrosion and abrasion.
4. The cable-compressing gland used within the cable accessory accomplishes both a firm anchoring of the cable and effective waterproofing for multi-conductor cables. Neoprene sealing gaskets are used at every joint to insure a watertight connector assembly.
5. The cable accessory is designed to accommodate a Kellems stainless steel wire strain relief grip for additional cable locking.
6. A left-hand thread is used on the cable accessory to prevent inadvertent loosening.
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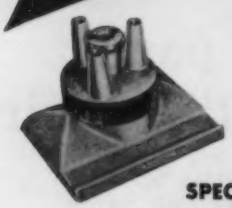

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Co., 500 Fifth Ave., New York 36, N. Y.

Circle 148 inside back cover

Thermostats—Brochure, 8 pp. Describes sensitive detecting elements used on motors, cycling systems, electrical appliances and regulating systems. Franklin Dales Co., 180-184 E. Mill St., Akron, Ohio.

Circle 149 inside back cover

High Pressure Hose Couplings—Bulletin 115, 8 pp. Contains data on units for high pressure air, steam, and hydraulic liquids. Hose Accessories Co., 2704 N. 17 St., Philadelphia 32, Pa.

Circle 150 inside back cover

Non-Indicating Pressure Transmitter—Data sheet, 2 pp. Describes a non-indicating pneumatic pressure transmitter, for vacuum or pressure measurement. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

Circle 151 inside back cover

Fundamentals of Thermoplastic Extrusion—Bulletin 1029, 32 pp. Contains both practical and theoretical discussions of the extrusion process. Also deals with the extruder, screw, die and post-extrusion equipment. Monsanto Chemical Co., Springfield, Mass.

Circle 152 inside back cover

Rack and Panel Connectors—Catalog R2, 12 pp. Contains diagrams and data on keyed panel shells, miniature, circular and printed circuit units. American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.

Circle 153 inside back cover

Solenoids and Coils—Booklet, 6 pp. Contains diagrams and data on solenoids, wound, molded and metal-enclosed coils. Anderson Controls, Inc., 2777 Mannheim Rd., Des Plaines, Ill.

Circle 154 inside back cover

Casters—Brochure, 4 pp. Contains data on units for appliances and furniture. Nagel-Chase Mfg. Co., 2811 N. Ashland Ave., Chicago 13, Ill.

Circle 155 inside back cover

Relays—Catalog R-11, 11 pp. Contains data and diagrams on relays, switches, and specialized controls.

(Continued on page 374)

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Thousands of hours... thousands of dollars saved by a modern miracle... DETREX Sonicleaning!

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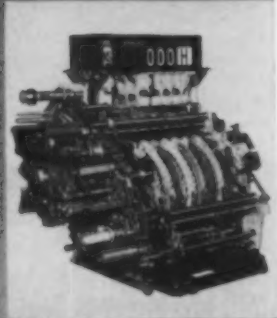

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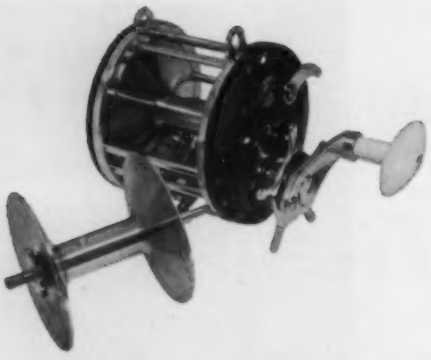

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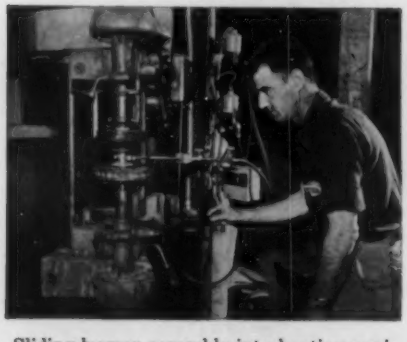
Inserting fluxed spindle and EASY-FLO silver alloy ring into lower half of spool. Assembly is completed when upper half of spool is pressed onto spindle. Press fit is necessary to maintain proper joint clearance between brass spool and steel spindle at brazing temperature.



Sliding burner assembly into heating position. Weight of upper platen assures accurate joint fit when ring of EASY-FLO alloy melts. Fuel is mixture of city gas and oxygen. Operator brazes 20 to 30 spools per hour.

This Yarn Has Fishermen Reeling ...With Absolute Confidence

Anybody who has ever caught a big fish knows the importance of a good reel. That's why manufacturers of fishing tackle are striving constantly for improvements in both design and production methods.

For example, when nylon line first appeared, Ocean City Manufacturing Company, the country's largest manufacturer of fishing reels, realized that the design of the reel spool would have to be changed. This because, with a big one on the line, the tremendous compressive forces of tightly wound elastic nylon often caused the spool flanges to spread so that the spool bound against the reel housing. Silver brazing with Handy & Harman EASY-FLO 45 silver brazing alloy and HANDY FLUX permanently and simply solved this serious problem.

Originally the spools were assembled from two fully machined brass forging halves with the hollow hub of each half fitted over a solid steel spindle with the drive clutch at one end. Each half was secured with ⅛" stainless steel pins driven through the spool hub into the internal spindle.

The same spool components are still used except that now semi-machined brass spool halves are silver brazed directly to the steel spindle with a preplaced ring of EASY-FLO 45 alloy. The shear strength of the brazed joint now exceeds 40,000 psi and because of the greater area of adherence to the spindle (as compared to two stake points previously used) spool hub creep toward the spindle ends is eliminated. The alloy cost is only 1.3 cents. The assembled spool is now finish-machined as a unit. The machining time once required for drilling and aligning has been eliminated. And when time is reduced and a product is improved, costs are reduced and sales are improved.

These same benefits could easily apply to the production of your product. The simple fact is that silver brazing with Handy & Harman brazing alloys has paid off handsomely for those who use it. The only way to find out if and how your product or methods fit the picture is to ask us —we'll be delighted to work with you all the way.

TO HAVE AND TO HOLD

BULLETIN 20 tells you why high strength, speed and economy are inherent in EASY-FLO silver brazing. Also gives Handy information about joint design and fast brazing methods. We'll be pleased to send you a copy.

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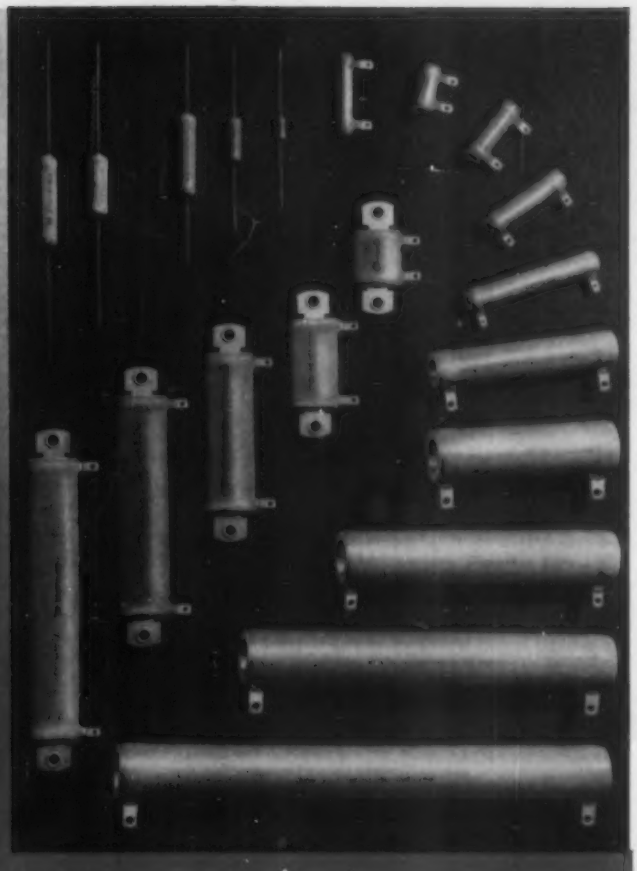

Famous Ward Leonard Vitrohm® vitreous-enameled resistors are now available in every style to meet all requirements of Military Specification MIL-R-26C including the severe bogeys on moisture resistance, thermal shock, insulation resistance and many other properties.

What's more, this line offers you *all* characteristics—G, V, and the exacting Y—and *all* specification sizes and resistance values—even the highest values using the finest wire (0.00175" dia.) permitted by the spec.

Tab-terminal, axial-lead and stack-mounting types are available in styles and characteristics shown in table.

For complete data on these MIL-R-26C resistors, write us for Bulletin 12. (And incidentally, for Vitrohm resistors to *highest commercial and industrial standards*, get W/L Catalog 15.) Ward Leonard Electric Co., 63 South Street, Mount Vernon, N.Y. In Canada: Ward Leonard of Canada Ltd., Toronto.

ENGINEERING DATA

TYPE	STYLE	AVAILABLE IN CHARACTERISTICS	RESISTANCE RANGE
Stack Mtg.—Tab	RW20 thru 24	G	All values in Spec.
Tab terminal	RW29 thru 47	V, Y* and G	All values in Spec.
Axial lead	RW55 thru 59	V and G	All values in Spec.†

*Characteristic Y applies to styles RW30, 33, 37 and 47 only. Characteristic Y is similar to V but requires high insulation resistance at end of moisture-resistance tests.

†Maximum values for single-layer-wound resistors with 0.00175" diameter wire.

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Vibration Resistance:	10-55 cycles at 1/16" double amplitude 55-500 cycles at 15 "G" 55-1,000 cycles at 15 "G" 55-2,000 cycles at 20 "G"
Temperature Range:	—55° to +85°C. —65° to +125°C. —65° to +200°C.
Coils:	Resistances—1 ohm to 50,000 ohms Arrangements—single coil; two independent coils, either or both of which will operate unit
Insulation Resistance:	1,000 megohms at room temperature 100 megohms at 200°C.
Dielectric Strength:	450 to 1,000 V., RMS
Operating Time:	24 V. models 10 ms. or less; dropout less than 3 ms.
Contacts:	30 V., D.C.; 115 V., A.C.; 2, 5, 7½ and 10 A., resistive; 2 and 5 A. inductive. Minimum 100,000 cycles life. Low interelectrode capacitance—less than 5 mmf. contacts to case; less than 2½ mmf. between contacts. Special Ratings: to 350 V., D.C., 400 MA., or other combinations including very low voltages and amperages or amperages to 20.
Operational Shock Resistance:	30, 40 and 50 "G" plus
Mechanical Shock Resistance:	up to 1,000 "G"
Mounting:	9 standard arrangements to meet all needs —plus ceramic plug-in socket.
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Bulletin R-250 gives more complete data. Send for a copy.

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Catalogs and Bulletins.....continued

Ohmite Mfg. Co., 3627 Howard St., Skokie, Ill.

Circle 156, inside back cover

Adapters for Flexible Shafting—Brochure, 15 pp. Contains information and diagrams on dual drive and right-angle adapters. F. W. Stewart Corp., 4311 Ravenwood Ave., Chicago 13, Ill.

Circle 157, inside back cover

Pumps and Pump Motors—Catalog 957, 12 pp. Contains diagrams, data and charts on rotary pumps and hydraulic pump motors. Geo. D. Roper Corp., Rockford, Ill.

Circle 158, inside back cover

Air and Hydraulic Cylinders—Bulletins (2), Contains data on units capable of 150 psi (air) and 2000 psi (oil). Ortman-Miller Machine Co., Inc., 15-143 St., Hammond, Ind.

Circle 159, inside back cover

Copper-clad Laminate—Brochure 755, 4 pp. Describes laminate developed for printed circuits used in radio and television industries. Formica Corp., 4411 Spring Grove Ave., Cincinnati 32, Ohio.

Circle 160, inside back cover

Phenolic Molding Compound—Pamphlet, 4 pp. Contains data on mineral-filled compound for electrical insulations when exposed to high humidity for long periods of time. Hooker Electrochemical Co., Walck Rd., N. Tonawanda, N. Y.

Circle 161, inside back cover

Synchronous Timing Motors—Data sheet 150, 2 pp. Contains data on units for timers subjected to temperatures up to 165 F. Lux Clock Mfg. Co., 95 Johnson St., Waterbury, Conn.

Circle 162, inside back cover

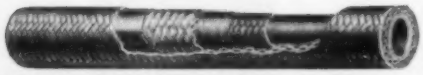
Air and Vacuum Pumps—Catalog, 16 pp. Contains data on construction, dimensions and capacities of rotary positive air and vacuum pumps, gas boosters and air motors. Leiman Bros., Inc., 102 Christie St., Newark 5, N. J.

Circle 163, inside back cover

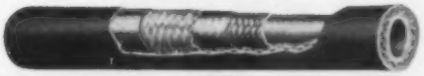
Silicones—Catalog, CDS-97. Contains 115 different application for silicones: rubber products, electrical insulation,

(Continued on page 376)

Specify These Aeroquip Hose Lines For Fluid Line Systems Up To 3000 psi.*



AEROQUIP 1503 AND 1502 HOSE is constructed with a synthetic rubber inner tube, a reinforcing layer of single wire braid, and an oil and mildew resistant cotton braid cover. Tube sizes from ¼" through 2½".



AEROQUIP 2651 AND 2652 HOSE features the same tough construction as 1503 Hose, but has an oil, mildew and abrasion resistant rubber cover. Tube sizes from ¼" through 3".

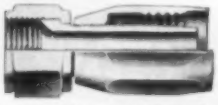
Dash size (in 1/16 in.)	4	5	6	8	10	12	16	20	24	32	40	48
O. D. Tube size	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2	3
Hose I. D.	3/16	1/4	5/16	13/32	1/2	5/8	7/8	1 1/8	1 3/8	1 13/16	2 3/8	3
Hose O. D.	33/64	37/64	43/64	49/64	59/64	1 5/64	1 15/64	1 1/2	1 3/4	2 7/32	2 7/8	3 19/32
Working psi.	3000	3000	2000	2000	1750	1500	800	600	500	350	250	200
Min. burst psi.	12000	10000	9000	8000	7000	6000	3200	2500	2000	1400	1000	800
1503-1502 Hose Min. bend radii	1 15/16	2 3/16	2 5/8	4 3/8	5 1/2	6 1/2	7 3/8	9	10 1/2	13 1/4		
2561-2652 Hose Min. bend radii	3	3 3/8	4	4 3/8	5 1/2	6 1/2	7 3/8	9	10 1/2	13 1/4	24	33

*Specify Aeroquip Teflon Hose For Chemical And High Temperature Applications

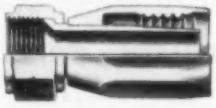
ALL DIMENSIONS IN INCHES

END FITTINGS AVAILABLE

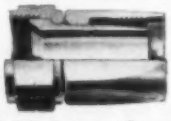
Male Pipe—¼" to 3"



J. I. C. Swivel—¼" to 3"



S. A. E. Swivel—¼" to ¾"



P. T. T. Swivel—1" to 2"

Special Elbow Fittings Are Also Available

Aeroquip 1503, 1502 and 2651, 2652 Single Wire Braid Hose and Reusable Fittings offer many advantages in the design of medium pressure fluid line systems. Recommended for hydraulic, lube and fuel oil, water and air lines, Aeroquip Flexible Hose Lines are superior in installations subject to vibration, stress or flexing. Because of their flexibility, Aeroquip Hose Lines are easy to install in confined spaces, with fewer elbows or adapters than are required with rigid piping or tubing.

REUSABLE HOSE FITTINGS

All Aeroquip Fittings are detachable and reusable. Fittings and hose can be assembled and disassembled quickly. With a supply of bulk hose and reusable fittings, hose assemblies can be made quickly and in quantity in the manufacturer's plant—without need for expensive swaging machines. Another advantage is that hose assemblies on engineering mock-ups can be modified and installed in seconds, using standard bench tools.

The equipment purchaser also benefits because Aeroquip Hose Lines can be replaced quickly and inexpensively right in the field, and the fittings used again and again.

SPECIFY AEROQUIP FOR QUALITY

Aeroquip quality standards are the highest in the industry. From raw materials to workmanship to final inspection, precise, accurate quality control is maintained, resulting in Aeroquip Products that give dependable performance under the most severe operating conditions.

Aeroquip produces a complete line of more than 55 different types of flexible hose—all with matching, reusable fittings—for almost every fluid-carrying application.

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textile finishes, lubricants, release and anti-foam agents. General Electric Co., Waterford, N. Y.

Circle 164 inside back cover

Polyethylene Closures–Data file. Contains information on 300 stocked sizes of the 10 standardized designs used to protect tubing, valves and hydraulic components. Protective Closures Co., Inc., 2207 Elmwood Ave., Buffalo 23, N. Y.

Circle 165 inside back cover

Stainless Steel–Booklet, 10 pp. Contains research data on 17-4 ph precipitation hardening stainless steel. The study includes compilation of mechanical properties after precipitation hardening at temperatures of from 800 to 1200 F, in 50 F steps, for both cast and wrought samples. Electric Steel Foundry Co., 2141 N. W. 25 Ave., Portland 10, Oregon.

Circle 166 inside back cover

Potentiometers–Technical paper 762, 10 pp. Discusses environmental effects on precision potentiometers. Helipot Corp., Newport Beach, Calif.

Circle 167 inside back cover

Resin-Rubber Compound–Booklet, 16 pp. Contains data on a blend of plastic and rubber as an extrusion. United States Rubber Co., Naugatuck, Conn.

Circle 168 inside back cover

Flat Annular Diaphragms–Brochure, 4 pp. Contains data and formulas on characteristics of diaphragms. Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 169 inside back cover

D-c Motor–Data sheet, 1 pp. Contains data on fhp unit. Induction Motors Corp., 570 Main St., Westbury, N. Y.

Circle 170 inside back cover

Centralized Lubrication Systems–Catalog 34-20, 16 pp. Contains diagrams and data on valves, pumps and units. Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill.

Circle 171 inside back cover

Silicone Rubber Compounds–Brochure, 10 pp. Contains data and charts on five new heat resistant compounds with Shore A Hardness of 40-

(Continued on page 379)

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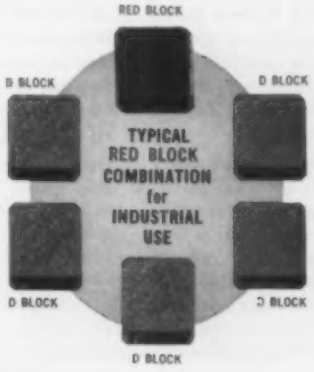

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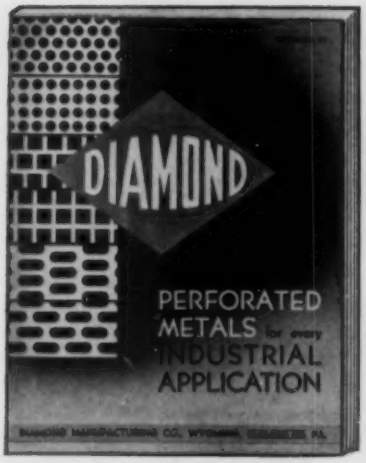

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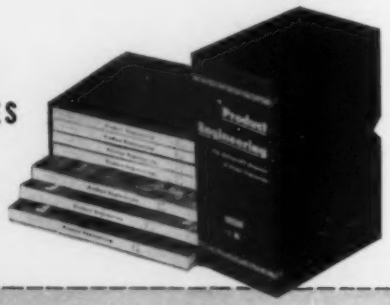

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80. Acushnet Process Co., New Bedford, Mass.

Circle 172, inside back cover

Phenolic Molding Compound—Pamphlet, 4 pp. Contains data on flock-filled, medium-impact material in nodular form. Hooker Electrochemical Co., Walck Rd., N. Tonawanda, N. Y.

Circle 173, inside back cover

Electrical Connectors—Booklet, 12 pp. Contains data on push-pull and push-lock units. Joy Mfg. Co., 1201 Mackland Ave., St. Louis 10, Mo.

Circle 174, inside back cover

Molded Plastics—Booklet, 8 pp. Contains charts and data on molding service. Richardson Co., 2750 Lake St., Melrose Pk., Ill.

Circle 175, inside back cover

Venturi Tubes—Bulletin 110-N1, 4 pp. Contains data and tables. Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle 176, inside back cover

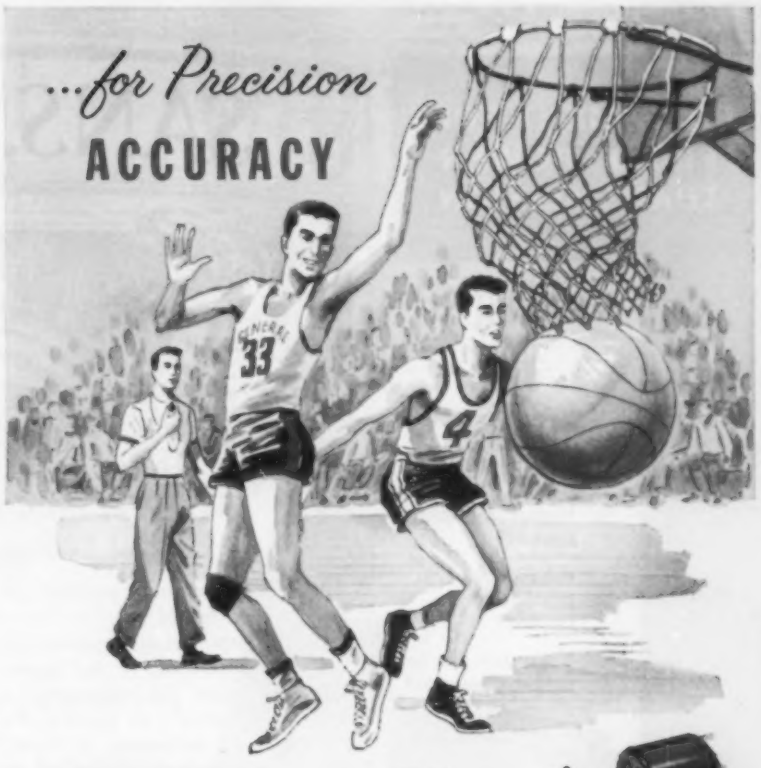
Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

Electrical Steels—Manual, 56 pp. Contains data and design curves of test results on three types and five different thicknesses of electrical steel. Armco Steel Corp., Middletown, Ohio.

Gears—Catalog 57, 112 pp. Contains information on gear materials and heat treatment, gear-cutting capacities, tooth forms, comparisons for milled-form and generated spur gears, AGMA Class 1 hp ratings, AGMA horse power formulas, shaft size formulas and tables. The Horsburgh & Scott Co., 5114 Hamilton Ave., Cleveland 14, Ohio.

American Drafting Standards Manual—13 pp. Contains tentative draft of Section 14—Structural Drafting of the Proposed American Drafting Standards Manual, Y14. ASME, 29 W. 39 St., New York 18, N. Y.



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MODEL A
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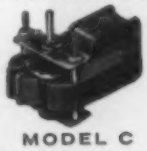
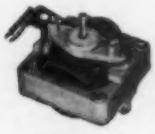


MODEL C
2-pole, shaded pole AC Induction Type



MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

MODEL O
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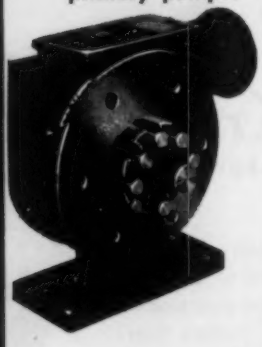

the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller-rotor design easily handles particles that would jam more tightly-fitted mechanisms — reduces cavitation, allowing higher speed operation* — develops high suction characteristics.

*Roller mechanisms permit higher speeds with any oil than most displacement designs.

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Ad Libbing by the Editor

Years ago I became acquainted with a young man by the name of George Baker. George was an expert in the making of mattresses. He had learned the trade "from the bottom up" as they say. There was no question that George made mattresses of highest quality. He worked for one of the nationally recognized manufacturers of mattresses.

Now George was the typical outspoken type of man who was always positive in the stand that he took. His favorite topic of conversation was "the damned boss." He berated his employers in no uncertain terms. He always bewailed the fact that he was the underdog and unappreciated in everything that he did.

I greatly admired George Baker. He was a wonderful family man. He had a very fine loyal wife and a brood of youngsters who have all made good.

George was always ambitious. He could never stand still. And it wasn't strange that there came a day that George launched out into business for himself. He rented a barn, bought a few old secondhand machines and with the help of his loyal devoted wife he launched into the business of making mattresses. He got up early in the morning to work in the "plant" and then spent a number of hours selling his wares. He was quite successful. And it was not surprising that he underwent a change of heart.

Whereas George had previously berated management, he now berated labor and the unions. So many of the men that he hired were lazy. They were stupid. They required detailed instructions for every little job they did. And if you didn't give the stupid boys a raise the unions were on your neck. Unions weren't any good anyhow. They blocked progress.

Such was the tenor of George's criticisms. First he was criticizing employers and business, and secondly he was criticizing workmen and unions. And in both of his stands he was slightly more than fifty per cent wrong.

It is regrettable that in too many instances a person is completely unable to see the other side of the problem. When George was an employee he was one hundred per cent antiemployer. And when George became an employer, he was almost one hundred percent antiemployee. That is putting is rather strongly because George was always trying to be fair minded. And in the later years when age had mellowed George his altruistic convictions were as positive as had been his radical and contradictory ideas that he had held during the earlier years of his life. In too many instances we are victims of our prejudices. Our prejudices dictate our conclusions while calm reasoning flies out the window.

Nature has a way of balancing extremes. And it is well that youth is that stage in which a man is chockfull of ideas, has few inhibitions and has tremendous courage to launch out in the fields "where angels fear to tread." Were it not so, there would be little progress in this world.

Michael Faraday, Sadi Carnot, Robert Fulton, Coleridge and many more of the great names in the arts

(Continued on page 385)

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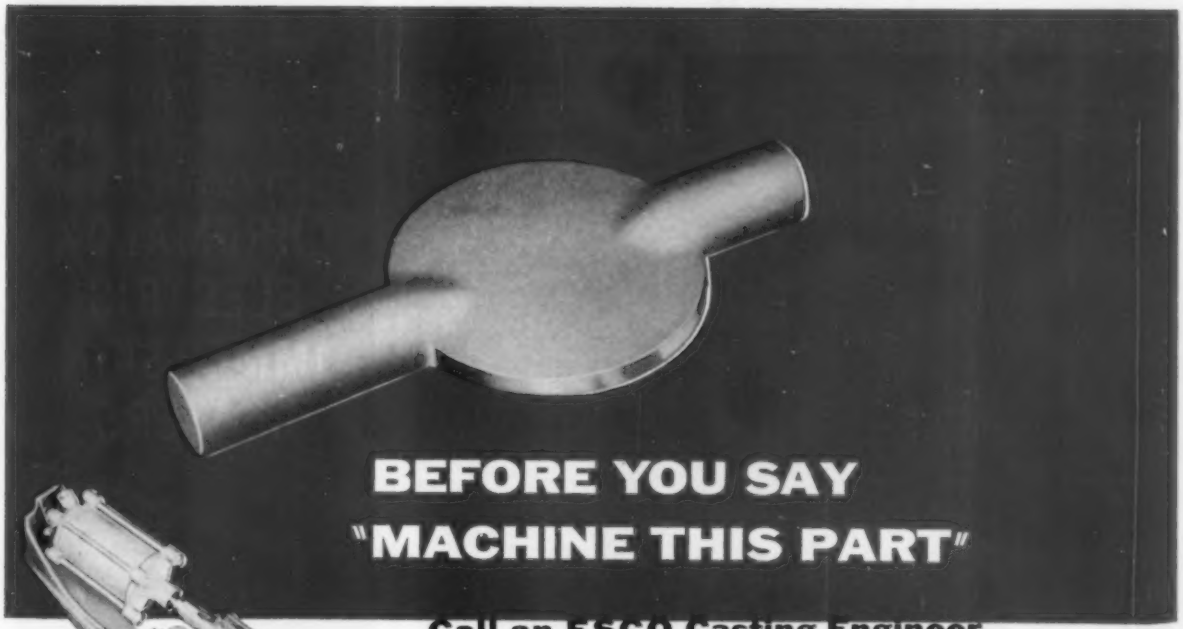

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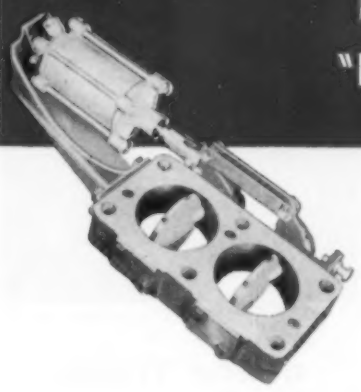

It's often the seemingly simple parts that cause the production "headaches". In this case the "butterfly"—the simple disk and shaft assembly in an exhaust gas actuated power brake. These small parts presented complicated machining and fabricating operations. The elliptical shape of the disk, the compound bevel of the disk edges, the slotting of short length of shafting, welding the shafting in perfect center and alignment on the disk and finally the turning of the shaft ends or bearings. All this fabrication had to be done in a heat-resistant steel to eliminate warpage of the disk, because the blow-by of exhaust gases would result in decreased operational efficiency of the power brake unit.

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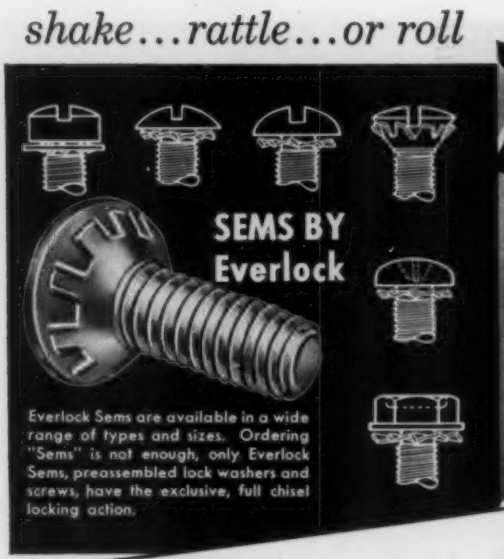

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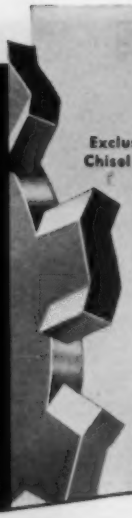

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and sciences were less than 35 years old when they achieved their greatest accomplishments. On the other hand, it was in the last stages of their lives when Carnegie, Rockefeller, Eastman and most of the other great philanthropists did their great deeds that contributed such boundless good to the progress and welfare of the human race. It seems that nature very properly in the early years endows a man with a wealth of ideas and an abundance of energy to develop those ideas. And in the last years, if mind and body have been kept going, the highly successful individual is given the opportunity to make his contributions to the social welfare of the nation.

If we study the matter to its logical conclusion we find that it is the youth of today who determine tomorrow's standards. It is youth that holds the whip hand in driving the chariot of destiny. Military revolutions to decide the next president or to settle political disputes are usually bred by generals and veteran politicians. Such revolutions usually contribute little or nothing to social progress. But the revolutions that have for their purpose great social and moral objectives such as freedom from oppression, recognition of the dignity of man and the right of freedom of worship, are not fomented by old age but are bred by youth. We must look to the classrooms to find the signs that point to tomorrow.

The uprisings in Hungary, the unrest in East Germany, the revolutions in the Satellite countries were all born or instigated by the youth of the countries, by the students in classrooms, by the young men working in the fields.

To find out what the thinking will be tomorrow, we should not questionnaire the people of middle age or old age. Their thinking has long been crystallized into a fixed formula. Their convictions have been trodden into paths worn into deep furrows by years of conformity to the philosophies and patterns that they were taught.

To discover the trends, be they political, social or otherwise, we must find out and analyze the thoughts of youth. It is only youth that demands changes while the old patriarchs whose mental operations have slowed to a snail's pace abhor the very thought of being forced to change anything.–G.F.N.

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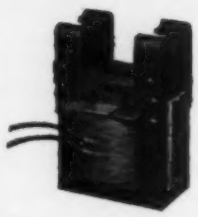

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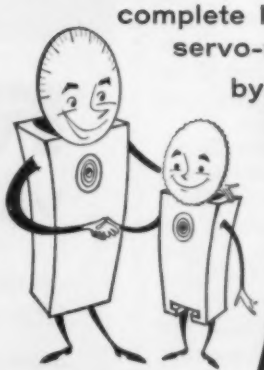

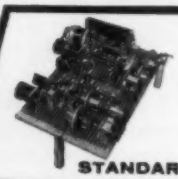

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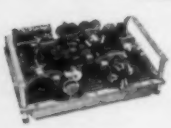

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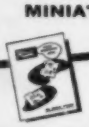

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ABSTRACTS

Testing and Training Engineers for Creative Ability

Carrier Corp. has arranged with the Psychological Services Dept. of Syracuse University for the development of tests to identify engineers who have above-average creative ability. As a result of a series of tests given to approximately 250 engineers already in the company and of known ability, a selected group of tests were chosen for use on new personnel.

The tests covered mechanical comprehension, personality and disposition, productive thinking, mathematical formulation, and spatial visualization. While the first two can show whether a man has creative ability the last three try to show how much.

Having examined the problem of identifying those with better-than-average creative ability, it is necessary to consider the second problem—that of properly motivating those chosen for that responsibility.

Assuming that the man is satisfied with his salary, has adequate office space, laboratory facilities, test instruments and funds (good working conditions) and has a supervisor receptive to new ideas, can creative talent be stimulated to make it available when needed?

The problem-solving technique which is described repeatedly in most literature on this subject of creative thinking, is that of the "brainstorming" session. This system was instituted with considerable success.

Abstracted from "Testing and Training Engineers for Creative Ability" by Robert W. Kubasta, Carrier Corp., Syracuse, N. Y., *Tool Engineer*, Dec. 1956.

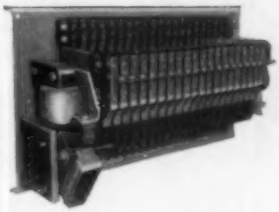
Electrical Effects In Stick-Slip Phenomenon

Electrical transients which accompany the stick-slip phenomenon in boundary lubrication have been investigated by an apparatus which permits simultaneous oscillographic measurement of any two of: the instan-

(Continued on page 389)

NEW EAGLE STEP SWITCH SIMPLIFIES CIRCUIT SEQUENCING

. . . for machine tools, presses, conveyors, processes



These 3 basic ideas are yours for simplified interlocking or sequencing of multiple load circuits. Any and all three will eliminate many other electrical components, and cut your initial cost.

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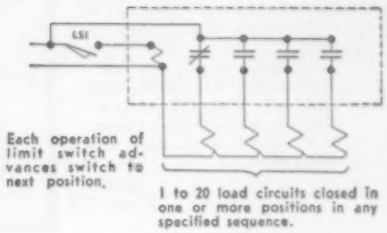
LSI
Each operation of limit switch advances switch to next position.
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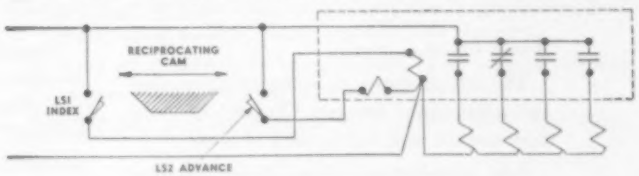
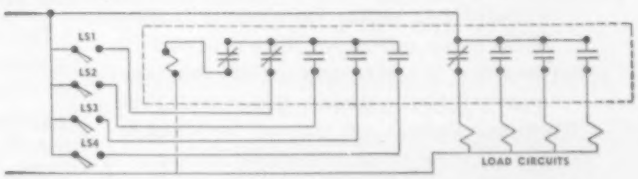


Interlock sequence with several limit switches: Each limit switch advances the Eagle step switch one position. Switches must operate in sequence or the step switch won't advance.



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taneous load, the instantaneous frictional drag, the electrical transient potentials, during the stick-slip motion. The phenomenon has been investigated with unlubricated metal-metal contact using four metals in various combinations, lubricated metal-metal contact using combinations of metals and five lubricants, and metal-plastic contact; in all cases, the contact was a sliding contact at low speed since this accentuates the stick-slip phenomenon. Definite time correlation between the mechanical stick-slip and the electrical transients has been found. The characteristics of the electrical discharge appear to favor a charge-discharge mechanism rather than a thermoelectric potential or a dielectric breakdown mechanism, although further experiments are necessary to provide unambiguous proof of such a conclusion. Certain related frictional experiments were performed which, however, also favor such a mechanism.

Conclusions: Stick-slip phenomenon in boundary lubrication is accompanied by an electrical transient of the nature of a discharge.

Mechanical stick-slip and the accompanying electrical transients are observed in the dry friction between metals, both if they are different or from the same stock. They are also observed in lubricated frictional contact between the metals and various plastics which were thick enough so that electrical breakdown was unlikely to have occurred.

Electrical transients are accompanied by a change in the frictional drag. The period of time during which the change in drag takes place is long compared to the duration of the transients, but is still small; the transients usually occur about at, or exactly at, the beginning of the slip, but a few occur at other times.

During stick-slip the large changes in the measured drag are not accompanied by noticeable changes in the measured vertical load.

The electrical discharge and drag change in metal-plastic frictional contact show more regularity than do those in metal-metal contact. The quantity of charge involved depends directly upon the change in frictional resistance.

The transfer of charge during stick-

(Continued on page 391)

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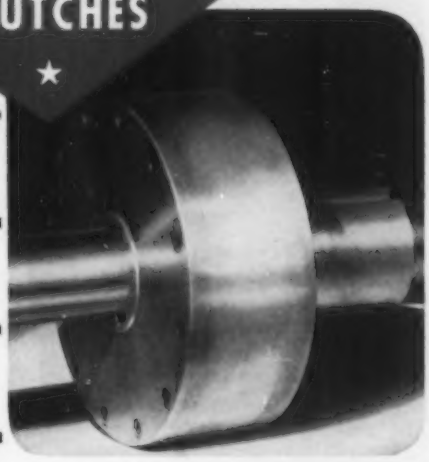
★



1 LONG LIFE because the rolls have no localized wear points.

2 NO JAMMING even after long wear.

3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.

50 YEARS of satisfactory service proves you can depend on Hilliard Over-Running Clutches and Couplings for long service on—

- DUAL DRIVES for pumps, fans, blowers and boiler stokers. (Many installations have a record of over 20 years without repair.)
- TWO SPEED DRIVES for dry cleaning machines, laundry equipment, conveyors, paper processing machines, slitters, forming rolls and automatic machinery.
- RATCHET ACTION for printing press ink rolls, coal feeders, press feeds, honing machines, bakery equipment and conveyors.
- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

★ CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS
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MD PRODUCTS

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LOOK to Sinko NYLON to solve your Molded Parts Problems

Especially those small, intricate shapes that require certain unique properties found only in Sinko NYLON. Such as: Toughness; Light Weight; Resilience; Resistance to Heat, Wear, and Abrasion; Electrical Insulation; Quiet Operation; Self-lubrication.

Here are but a few of the many and varied applications of Sinko NYLON moldings:

- Bearings, Washers
- Coil Forms
- Connectors
- Gears, Insulators
- Rivets, Screws
- Rollers, Valve Seats
- Wearing Surfaces

Let us make test samples of your parts from Sinko NYLON or other Thermoplastic; or if you prefer, we'll send you the raw material.

Note: Nylon rivet shown molded for Illinois Tool Works

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Ametron® ELECTRONIC CRANE SCALES

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slip in metal-plastic contact has been confirmed in two additional ways; namely, by dusting charged powders on the plastic, and by sliding polymer powders down metal sliders.

Abstracted from "Electrical Effects Accompanying The Stick-Slip Phenomenon in Boundary Lubrication," by S. M. Skinner, J. Gaynor, and G. M. Sohl, Case Institute of Technology, Cleveland 6, Ohio, The American Society of Mechanical Engineers Paper No. 56-A-163, presented at the ASME meeting, N. Y., November 25-30, 1956.

Some Problems and Design Factors Concerning Noise in Motor-Driven Home Appliances

During recent years, the ratio of material to labor cost of mass-produced products has been increasing, mainly due to the more effective use of automatic processes. In turn, this has stimulated efforts towards producing greater output per pound of material in such items as small motors, and towards greater utility per pound in such products as home appliances. This trend, along with shifting of appliances from basement to kitchen or first floor utility areas, emphasizes the reduction of objectionable or undesirable sound as a major design factor.

Each part of an appliance has mechanical resonant frequencies determined by design and manufacturing variations. Sheet metal housings and tubs common to many appliances have a number of resonant frequencies which vary from machine to machine. Slight variations can cause appreciable differences in the resonant frequencies of flat plates. The point at which vibration is applied and the part stressed can also vary response characteristics.

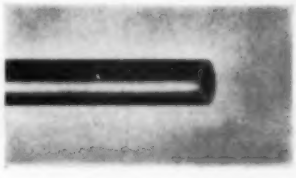
Besides the mechanical resonances, cavities such as washer tubs may have acoustical resonance similar to a Helmholtz resonator or an organ pipe. When the resonant frequencies of such cavities are near the applied frequencies, noise amplification will occur, especially when the cavity is empty. If frequencies of applied forces coincide or are near the resonant frequencies of the appliance, then radiated noise level is particularly high unless the vibrations transmitted

(Continued on page 395)

DANCO ANNOUNCES

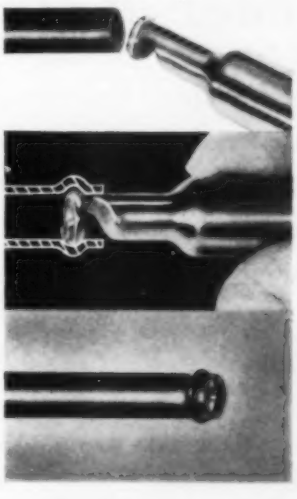
revolutionary new

TUBE FITTING DESIGN



simple . . . fast . . . versatile . . . with NO REDUCTION IN I. D . . . . NO REDUCTION IN FLOW!

Sealed tight, quickly-assembled fittings by Danco present limitless new opportunities in plastics and rubber tube applications.



3 simple steps!

1. Cut tube to desired length
2. Slip fitting on tube
3. Insert special non-corrosive ring and tighten connection.

No welding! No threading! No special adhesives! Installation is simple, mechanical, complete in seconds. And it's just as easy to disconnect a Danco fitting.

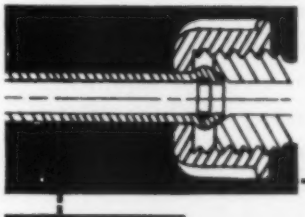
Here's the most sensational development in tube fittings in the last ten years. The new Danco Fitting has been designed *especially* for flexible tubing . . . A MODERN FITTING FOR MODERN TUBING.

COMPLETELY MECHANICAL—

With no intricate equipment. Requires only the simple Danco ring-holder and rings (available in a wide range of sizes for various tube diameters.)

DANCO TUBE FITTINGS

Wear-and corrosive-resistance nylon. Available in terminals, tees, 90°, and special fittings designed for specific applications.



FREE APPLICATIONS SURVEY

For more information on the NEW Danco tube fitting, write today outlining requirements. Specify application, please.

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A SUBSIDIARY OF NICHOLSON FILE CO.

Gentlemen: More facts, please.

☐ Descriptive literature Danco Fittings
☐ Have your representative call.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

APPLICATION.....
(SPECIFY TUBING USE)

. . . pioneers in nuclear energy since 1936

At the University of California Radiation Laboratory, Berkeley and Livermore, there is an unusual spirit among scientists and engineers — a spirit stimulated by association with pioneers in nuclear research who encourage development of new ideas, techniques, and individual initiative.

Since its founding in 1936, UCRL has contributed an impressive list of achievements to the world's knowledge of the atomic nucleus — from development of the cyclotron and Bevatron, to electromagnetic separation of uranium-235, to the discovery of the antiproton and antineutron.

These accomplishments have, of course, stemmed from an outstanding group of men working with unmatched laboratory facilities. But just as important—and the key, perhaps, to UCRL's successes—has been the spirit with which these men work.

For UCRL is managed and directed by scientists and engineers—men who are liberal with their own knowledge and enthusiastic in the encouragement of their teammates' new ideas and new techniques.

This is the constant and continuing spirit of UCRL. It is to be found in each new and expanded project—whether it involves pure or applied science. It keynotes work on nuclear weapon design, nuclear propulsion, controlled thermonuclear energy (Project Sherwood), and high current accelerators, as well as such problems as the application of radioactive substances to biology and medicine.

The UCRL "spirit" appeals to a particular kind of scientist and engineer—to men of ability and imagination, to men who wish to move forward and challenge the unknown. If you wish additional information, write to the Director of Professional Personnel, University of California Radiation Laboratory, Livermore, California.

UNIVERSITY OF CALIFORNIA RADIATION LABORATORY • BERKELEY • LIVERMORE

to the Engineer who seeks a wide variety of assignments

To non-aircraft engineers:

Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering – at full pay.

An unparalleled variety of assignments awaits you at Lockheed's Engineering Flight Test Division.

Lockheed diversification is the reason. This year alone flight tests must be conducted on new turbo-compound and prop-jet transports, extremely high-speed fighters, new types of jet trainers, patrol bombers, radar search planes and aerological aircraft. In development are jet transports and nuclear applications to aircraft and a large number of classified aircraft.

You not only work on many types of aircraft in Lockheed Flight Test, your work within each plane varies widely. Each flight test presents new problems, frequently requires new approaches.

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POWER PLANT: engine and after-burner; fuel systems; oil, fire extinguishing and air conditioning systems.

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STRUCTURAL FLIGHT MEASUREMENT

INSTRUMENTATION: systems design, calibration and maintenance.

WEAPONS: fire control systems, ordnance, rocket sleds.

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Positions are open for:

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with and without aircraft experience
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Brief résumé form at right is for your convenience in contacting Lockheed.

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Field of engineering

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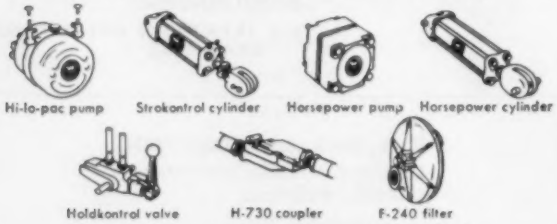
We call it "MARILYN"—it's got everything!

The Char-Lynn HOLDKONTROL VALVE combines ALL features in 1 valve

- ✓ Built-in HOLDKONTROL. This frees the operator from holding the valve in operating position. The valve can be manually returned to neutral, or it will return by itself when pressure exceeds the relief valve setting.
- ✓ Built-in relief valve. Large capacity. Can be set to operate at standard pressure settings . . . 500, 750, 1000, 1500 and 2000 P.S.I.
- ✓ Can be easily converted to control either single or double acting systems.
- ✓ Can be converted to complete manual operation—simple field change.
- ✓ Has 3 point reversible mounting—can be mounted in any position.
- ✓ Will withstand surge pressures up to 5000 P.S.I. It can be safely connected to virtually any hydraulic system.
- ✓ Will sensitively handle volumes from 2 G.P.M. to above 12 G.P.M.
- ✓ Swivel control handle can be rotated through 360 degrees to the most convenient operating position.
- ✓ Special 3-way control without Holdkontrol available for loaders, lift-trucks, etc. Spool change allows operator to inch load up or down.

SPECIFICATIONS

CAPACITY 2 gpm to 12 + gpm • **SAFETY** Relief valve can be set to protect for any range of operation up to 2000 psi • **MATERIAL** Precision-cast body of high tensile strength aluminum bearing alloy. Hardened ground and lapped spool • **PORTS** ¾" N.P.T.—Inlet and outlet.—½" N.P.T.—Cylinder ports • **MOUNTING** Any two of the three pads can be used. Pads reversible for alternate top or bottom mounting • **CONTROL** Spring-loaded . . . Control handle returns to neutral. Handle swivels 360° and may be operated in the most convenient position • **SYSTEMS** Open or closed center. Single or Double Acting. Open free flow or restricted flow • **HOLDKONTROL** Valve will hold when placed in an operating position until it is either manually returned to neutral or until the relief valve operates which releases the lock. This lock can be turned on or off by regulating a screw on operating port face.



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Catalog and Engineering Data Free on Request . . . Your Inquiries Invited

PE4

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NOW TRY THE M-F TWO-WAY LOCK NUT!

DOUBLE CHAMFERED—May be *automated without selective devices.* Starts from either end—locks in body of nut, not at the crown. Write for specifications.

***Ask us why.*

Where positive locking is absolutely essential, the M-F *Uni-Torque* lock nut becomes *more* than a means of applying uniform bolt tension—*more* than a smooth-running production line.

The M-F Uni-Torque delivers *safety* . . . fidelity of design down to the last thread. *Performance as engineered!*

No need to take a chance—M-F Uni-Torque Lock Nuts cost NO MORE (cost LESS to *use!*)*

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Brass
MAKEPEACE Roll Formed Stock
STRIP
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Copper
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Combines Quality and Accuracy at Minimum Cost
Manufacturers everywhere who want Roll Formed Stock accurately produced to minimize labor and material costs in fabrication have found Makepeace the perfect answer. We are in a position to supply your requirements in a large variety of sizes and shapes at prices geared to economy. Write today for further information.
D. E. Makepeace Company, Attleboro, Mass.
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ENGELHARD INDUSTRIES

to the appliance are very low, such as obtained by high isolation.

However, the design of the simplest and lowest cost system which isolates motor forces from the appliance requires that the appliance and motor designer meet on a common ground.

Abstracted from "Some Problems and Design Factors Concerning Noise in Motor Driven Home Appliances," by E. R. Cunningham and G. L. Wolfert, General Electric Co., Fort Wayne, Ind.. AIEE Paper No. 57-27, presented at AIEE Meeting, New York, N. Y., Jan. 21-25, 1957.

So You're Going To Read a Paper!

Suppose you have been asked to "present" or "read" a "paper" at a convention session of your primary technical society. Your topic has been selected and the session chairman has indicated a definite time limit. Now what do you do? If you are like most of us, you will probably get your notes together, write your paper have it mimeographed, run through it aloud a time or two, and then present it at the meeting by reading it in a non-too-effective way to your disappointed peers.

What can a convention speaker do to improve his chances of communicating effectively? The following may suggest ideas to you which you may find at least worth thinking about if not worth actually using at some time in the future.

It is almost too obvious that a good communicator must be saturated with his subject. The concepts you are going to discuss should be so thoroughly thought through that you will have no difficulty in capturing and recapturing the bases for each main point and supporting details at the time you are bringing them out before your audience.

The subject matter should be put together in a structural pattern which the listener can recall easily later on, and which he can recreate quickly for himself as a guide while the speaker is talking.

Main points should be limited in number (no more than five), and worded in a concise, clear, and interesting way. Explanations, illustrations, facts, and other supporting materials for these principal ideas should

(Continued on page 396)

Thermoid
FRICTION MATERIALS

Stop this giant drawworks

...keep this home washer going

Need rugged brake blocks to stop a 600 horsepower oil drilling draw works . . . or small friction units to control the cycles of an automatic washer?

Thermoid is the ideal source for these and many other *friction* and *rubber* components. For 75 years, Thermoid has satisfied the requirements of design engineers for high quality, long wearing, trouble-free Hose, V-Belts, Friction Materials and Molded Rubber Parts.

Thermoid multi-plant facilities are big enough to handle your largest mass production demands . . . small enough to make *personalized service* more than just a phrase.

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be selected to capture the greatest listener interest and understanding in the limited time allowed the speaker for his talk.

In the actual delivery of the speech there are obviously two major methods available to you, both of which are equally effective if done well. One is to use the written paper in developing a speech manuscript suitable for easy, conversational, oral reading. The other method of delivery is for you to speak from a brief outline of the subject or from notes.

One last word about the speaker's enthusiasm both before, and on the day of the talk: You should not only check your visual aids and other materials before the meeting time, you should also prepare yourself psychologically. Your feelings of friendliness and enthusiasm about your subject matter and the opportunity to share it with your associates and other professional people must be so vital and intense that they will be truly infectious, even to those in the back row. Let the group share with you the proper pride you have in your

HOLES are nothing at

A hole in steel is a "nothing-at-all" with engineered sides. And many costly things can happen to it: drilling, broaching, reaming, tapping, counterboring, countersinking, and so on. What's more, holes weaken the product, necessitate extra bosses, cause possible leaks, create corrosion pockets.

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NELSON® stud welding eliminates at least

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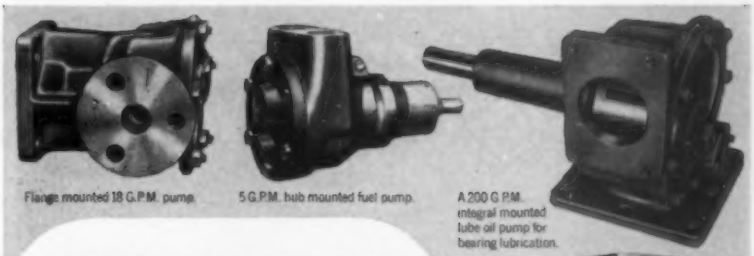
NELSON STUD WELDING . . .

subject, your chosen profession, and in your status as a fellow human being.

A little spontaneous feeling the paper you are planning to read can send a thought a long way.

From "So You're Going To Read A Paper!" by Harold O. Haskitt, Jr., General Motors Institute, Flint, Mich. Journal of Engineering Education, Jan., 1957.



Flange mounted 18 G.P.M. pump. 5 G.P.M. hub mounted fuel pump. A 200 G.P.M. integral mounted lube oil pump for bearing lubrication.

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Viking lube oil, fuel oil and coolant pumps, built to fit your equipment, are a specialty of Viking.

Shown here are only a few of many special pumps, ranging in size from 5, 10, 18, 90 to 200 gallon per minute. Smaller and larger pumps also available. Send today for folder 57Sx.

A 90 G.P.M. flange mounted pump with valve on head.

A 10 G.P.M. opposite port oil pump built to specifications.

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" pumps
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all!

half your "hole" engineering and production. All you do is squeeze a trigger, and you've got a threaded* projection end-welded straight, strong and accurate! It looks like a bolt, but it has no useless head sticking out the other side through the inevitable (and wholly unnecessary) hole!

NELWELD will fasten your product or structure better at less cost. Send for folder of cost-saving applications. Just mail the coupon.

*Many other standard types also available ... to hang, handle or hold.

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NICKELOID METALS
More Than a Metal—It's a Method
Beyond the design and production limits of ordinary metals rises Nickeloid Pre-Finished Metals, a versatile design material that transforms design ideas into product realities. Available in 14 finish-to-base metal combinations, this finished raw material opens wide new horizons in product design, adapts readily to standard production methods, inspires new products — new designs. Saves production time, costs and equipment investment, too, because it's PRE-finished.
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SINCE 1898
CHROME, NICKEL, COPPER AND BRASS FINISHES ON BASE METALS OF STEEL, ZINC, COPPER, BRASS OR ALUMINUM. SHEETS, STRIPS, COILS.
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NEW BOOKS

Design of Gray Iron Castings

ARTUR SCHAFF, *Battelle Memorial Institute, and* CHARLES F. WALTON, *Gray Iron Founders' Society, 6 x 9 in., 64 pp, paper bound. Published by Gray Iron Founders' Society, National City—E. 6 Bldg., Cleveland 14, Ohio. $3.*

This new manual presents casting design from the designing engineer's viewpoint, covering functional strength, performance, appearance and economy. It brings together pertinent information and data on design, taking advantage of the most recent developments in the casting industry.

Encyclopaedia of the Iron & Steel Industry

A. K. OSBORNE. *6 x 9⅝ in., 558 pp. Published by Philosophical Library, 15 E. 40 St., New York 16, N. Y. $25.*

The purpose of this encyclopaedia is to provide a description of the materials, plant, tools and processes used in the iron and steel industry, and in those industries closely allied to it. The information contained ranges from the preparation of the ore, down to the finished product, with definitions of technical terms employed.

The book is intended as a reference, not as a textbook, but the specialist might find information on subjects bordering his own.

Strength of Tubes Under Uniform External Pressure

WG. CDR. P. C. CLEAVER, *O.B.E., D.C. Ae. 8 x 13 in., 183 pp. Obtainable from British Information Services, Rockefeller Plaza Building, New York, N. Y.; about $4.25.*

This report traces the development of theoretical solutions to the problem of determining the strength of tubes subjected to uniform external pressure,

(Continued on page 399)

and describes an extensive series of tests to check the accuracy of the Sturm solution to this problem and the effects of material properties on collapse pressure. A total of 530 tests were made.

The mean collapse pressure of the tests designed to check the accuracy of the Sturm solution corrected for eccentricity effects exceeds the mean theoretical collapse pressure by 2.2 per cent, the standard deviation was 7 per cent, and the distribution approximately Gaussian. It is concluded that this theory may confidently be used to predict the strength of tubes under uniform external pressure applied to the sides only.

Fluids, Lubricants, Fuels and Related Materials

PB 121508, MERRELL R. FENSKE, *Petroleum Refining Lab., Pennsylvania State University.* 8 x 10½ *in.*, 193 *pp, paper-bound. Obtained from U. S. Dept. of Commerce, Office of Technical Services, Washington, D. C.* $3.50.

This report describes the current status of development work on Specification MIL-L-7808 oils and turboprop lubricants. Fluids of the PRL 3161 and PRL 3313 types are covered in this discussion.

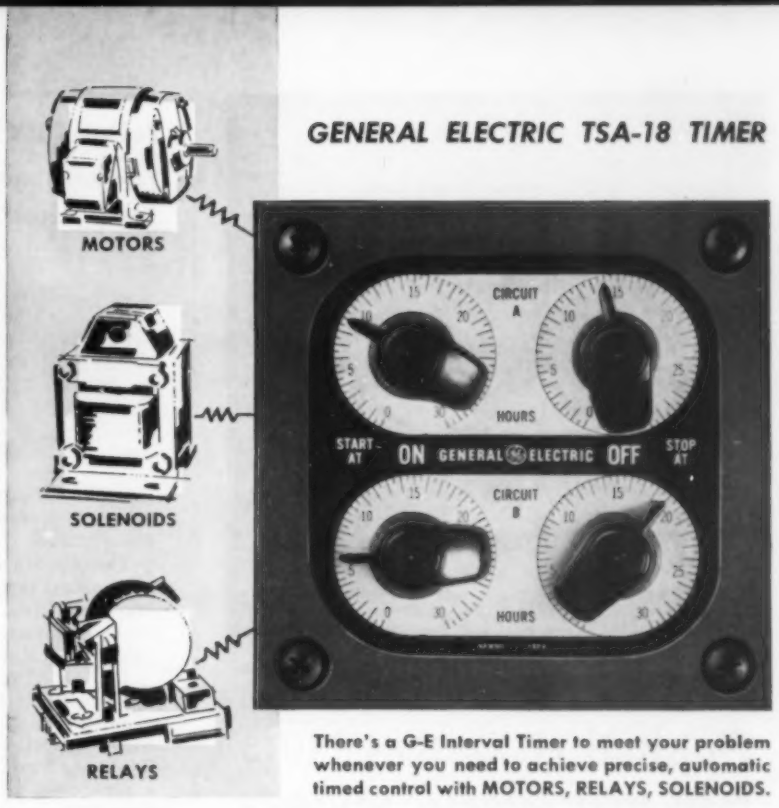
A single composition can be formulated to meet both Specification MIL-L-7808 turbine engine lubricant and Specification MIL-L-6387 synthetic hydraulic fluid. Five samples of Specification MIL-L-7808 type fluids have been submitted to the Wright Air Development Center by potential commercial suppliers. Data presented in this report indicate that only one of the five commercial fluids meets the viscosity-temperature requirements of the specification.

Generation of Electricity by Wind Power

E. W. GOLDING. 8¾ x 5½ *in.*, 318 *pp. Published* 1956 *by Philosophical Library, Inc.*, 15 *E.* 40 *St., New York* 16, *N. Y.* $12.

In recent years important work has been done on the use of wind power for the generation of electricity. The author of this book has taken promi-

(Continued on page 401)



There's a G-E Interval Timer to meet your problem whenever you need to achieve precise, automatic timed control with MOTORS, RELAYS, SOLENOIDS.

Save Money, Manpower with Automatic Timed Control of Machines and Processes

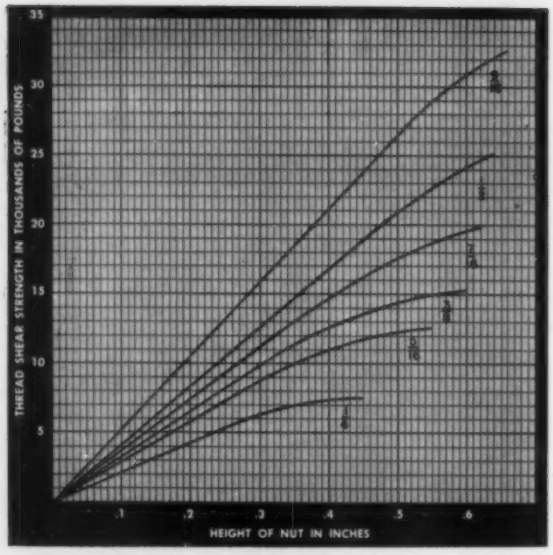
On all machines or process equipment where time or timing cycles are an important factor, General Electric TSA-18 Timers can reduce operating costs by freeing operators for more productive work and reduce waste and spoilage of material.

USED FOR THE AUTOMATIC start/stop of motors and the timed control of solenoids and relays, the TSA-18 offers you reliable control of time cycles, or combinations of time cycles, from 30 seconds to 30 hours. Setting accuracy of 1%, and repeat accuracy of ¼% assure precise control for the most critical applications. When required, the standard TSA-18 timer may be equipped with automatic reset and automatic recycling.

138 DIFFERENT MODELS of the TSA-18, plus many varied combinations of wiring, assure you of obtaining the exact time control, or combinations of time control, needed for your particular application. No matter what is required—regular interval timing, remote actuation, automatic resetting, automatic recycling, or sequential operation of several timers . . . they're yours with the TSA-18.

FOR INFORMATION as to exactly how the TSA-18 timer can save money and manpower on your machines or process equipment, contact your nearby G-E Apparatus Sales Office . . . or write for bulletin GEC-1223 to General Electric Co., Section 584-11, Schenectady 5, New York.

GENERAL ELECTRIC



Shear Strength...

Finished HEXAGON NUTS

fine and coarse threads

The above curves show how the proof load of a nut (the load causing the threads to strip) varies with its height. (The curves do not account for bolt characteristics or fatigue and safety factors.)

If you are buying load carrying capacity, the curves suggest that it may be more economical to:

1. Use a thicker nut—
2. Increase the fastener size—
3. Use more and smaller fastenings—
4. Use heat-treated nuts to develop full bolt strength (heat-treating increases nut proof load 30 to 50% over the above values)—

Variables of economical fastener design selection and assembly are discussed in the Engineering Data section of our catalogue that we will send upon request.

NATIONAL MACHINE PRODUCTS COMPANY

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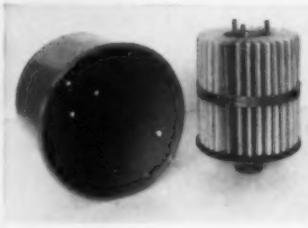

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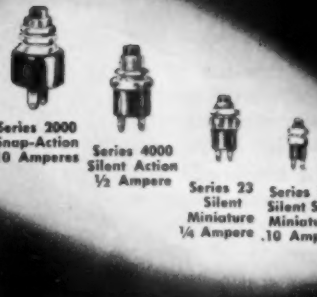

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nent part in this work, both in Britain and in other countries, on behalf of their governments and of the United Nations and its specialized agencies.

The book deals with wind surveys for the choice of suitable sites, with the structure and behavior of the wind and with techniques for measuring it. It also considers in detail the economy of wind power in relation both to large public supply networks and to isolated premises and communities. There is also a study of the use of wind power through the ages, an account of present-day activities, and a survey of future prospects.

Symposium on Reliable Applications of Electron Tubes

Sponsored by the Radio-Electronics-Television-Manufacturers Association. Paper-bound, 105 pp., 86 illustrations. Published by Engineering Publishers, GPO Box 1151, New York 1, N. Y. $5.

Reliability of electronic equipment of all kinds is primarily dependent on the reliability of electron tubes used. Papers printed in this report deal with several aspects of tube reliability as related to field experience, reliable circuits, design for reliability, and means of achieving improved reliability within tubes.

Some of the papers presented are on field techniques for reliability improvement, designing for reliability through proper application of tubes, application techniques for reliable circuit performance, mathematical analysis for reliable design, and receiving tube reliability studies.

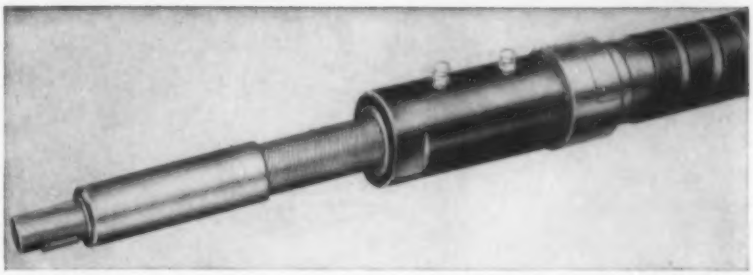
Standards for Zinc-Coated Products

ASTM Standards on Zinc-Coated Iron and Steel Products, Sponsored by Committee A-5 on Corrosion of Iron and Steel. 9 x 6, paper bound, 143 pp. Obtainable from ASTM, 1916 Race St., Philadelphia 3, Pa. $2.25.

This publication presents in convenient form for reference the various ASTM standards and tentative methods for test and specifications pertain-

(Continued on page 403)

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. **Torque (Lb. In.)** to be transmitted. (The starting torque should be used in making selections.)

2. **Operating Speeds (RPM)**—If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. Operating Raduis—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

RATINGS—The ratings for flexible shafts shown in the table below apply under the following conditions:

1. when the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. when the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. when the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE—How to use the table:
The problem is to transmit ½ HP at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.
1. Calc. Torque (lb. in.)—

$$\frac{\text{HP} \times 63000}{\text{RPM}} = \frac{.5 \times 63000}{1700} = 18.5$$

2. Correction factor for starting torque 1.5 x 18.5 = 27.75
3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.
4. Refer to Table No. 1. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

For Engineering Bulletin No. 570 and a free torque calculator, write

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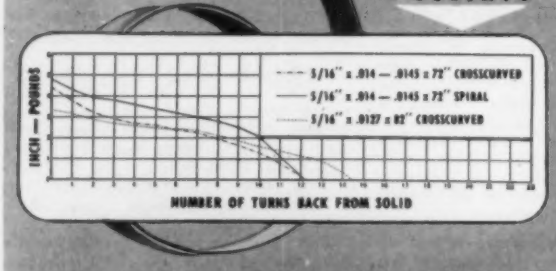
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ing to metallic coated iron and steel products. Standards, tentative specifications and methods of test represent the most up-to-date thoughts and practices. Included in this compilation are all specifications coming under the jurisdiction of Committee A-5. In addition, selected specifications written by Committee A-1 on steel, A-2 on wrought iron, B-1 on wires for electrical conductors, and B-2 on non-ferrous metals and alloys may be found. Included in the volume are 21 specifications of which four are new or recently revised; three recommended practices, two of which are new; and five methods of tests. Among the materials covered are wire, strands, fencing, sheets, hardware, terne-alloy-coated sheets and miscellaneous products.

Plastic Roller Bearing Race Separators

PB 121363, Dr. A. Gremer, Schweinfurt, Germany. 10½ x 8 in., paper bound, 25 pp. Published by U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $0.75.

Plastic bearings have been widely substituted for those of metal in German industry because of superior "critical operating properties," i.e., behavior of bearing materials under such unfavorable conditions as failure of lubrication, high local loading because of improper installation, and excessive speed. Outstanding properties of plastic bearings led to tests of suitability of plastics as roller bearing race separators.

Perspective—A New System for Designers

Jay Doblin, 9¾ x 12¼ in., 68 pp., Published by Whitney Publications, Inc., 18 E. 50 St., New York 22, N. Y. $5.

This volume presents a new system for drawing which is said to eliminate errors in product design, and speed up procedures that normally involve complicated mechanical drawings. It describes a basic method of drawing an object in direct perspective. Because it is direct, the designer has more control over the finished prod-

(Continued on page 405)

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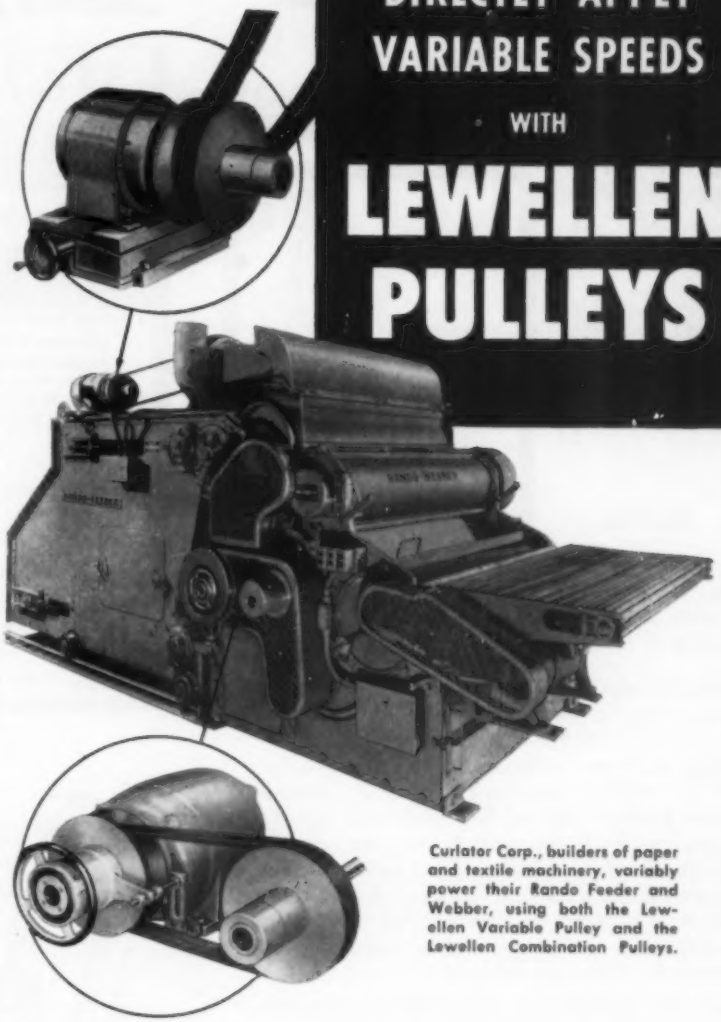

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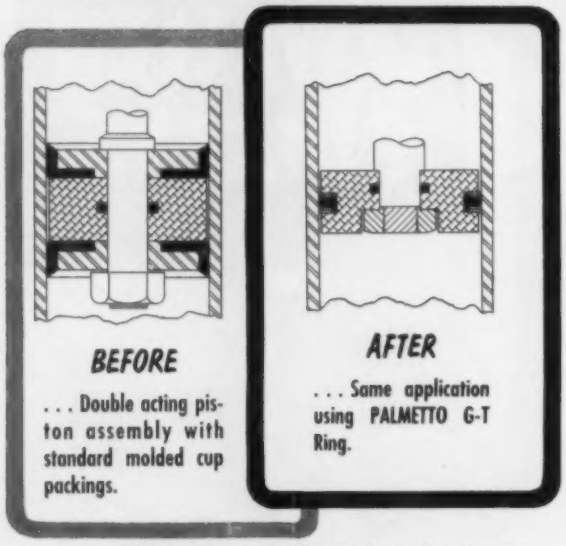

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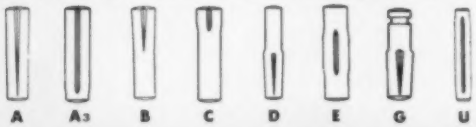

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Trigonometry Refresher For Technical Men

A. Albert Klaf, *Civil Engineer.* 5½ x 8 *in., paperbound, 606 pp. Published by Dover Publications, Inc., New York,* $1.95.

This answer text covers most important aspects of plane and spherical trigonometry, with specially selected questions and detailed answers.

First part of this book discusses plane trigonometry, covering angles, quadrants, trigonometric functions, graphical representation, interpolation, equations, logarithms, solution of triangles, and use of the slide rule. Second part covers application of plane trigonometry to special problems in navigation, surveying, elasticity, architecture, and various fields of engineering. Small angles, periodic functions, vectors, polar coordinates, De Moivre's theorem are fully examined. Third section of the book discusses spherical trigonometry and the solution of spherical triangles, with their application to terrestrial and astronomical problems.

Included also are methods of saving time in numerical calculations, simplification of the principal functions of an angle by use of a "shadow and perpendicular" concept, and practical information on calculation aids.

Theory of Land Locomotion

M. G. Bekker. 6 x 9 *in.,* 497 *pp. Published by University of Michigan Press, Ann Arbor, Mich.* $12.50.

Here is a comprehensive source of the information now available on the relations between a motor vehicle and the physical environment in which

(Continued on page 407)

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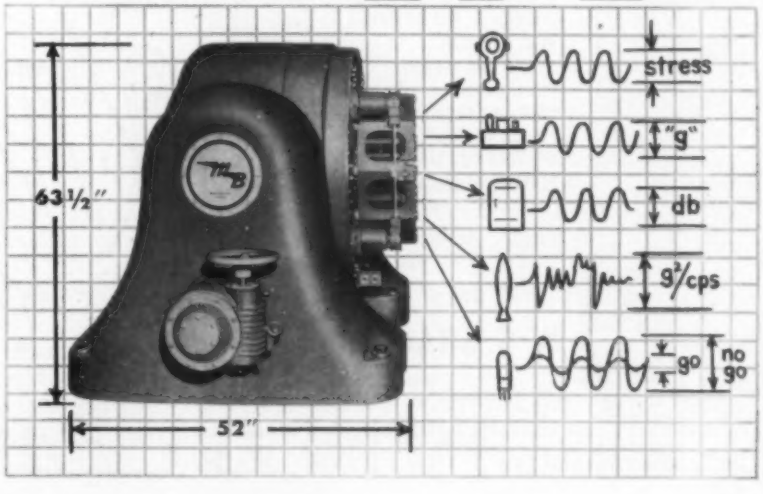

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Placing particular emphasis on off-the-road vehicles, the book discusses in detail problems of soil and snow mechanics; size-form relationships as an index of economy; terrain conditions; the process of moving tracks, skis, sleds, toboggans, rigid wheels, and pneumatic tires; static and dynamic behavior; dimensional analysis, testing, and over-all economy.

Elastically Mounted Motors and Engines

PB 121367, E. Stolte, *Hannover, Germany.* 10½ x 8 *in., paper-bound, 24 pp. Published by the U. S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $0.75.

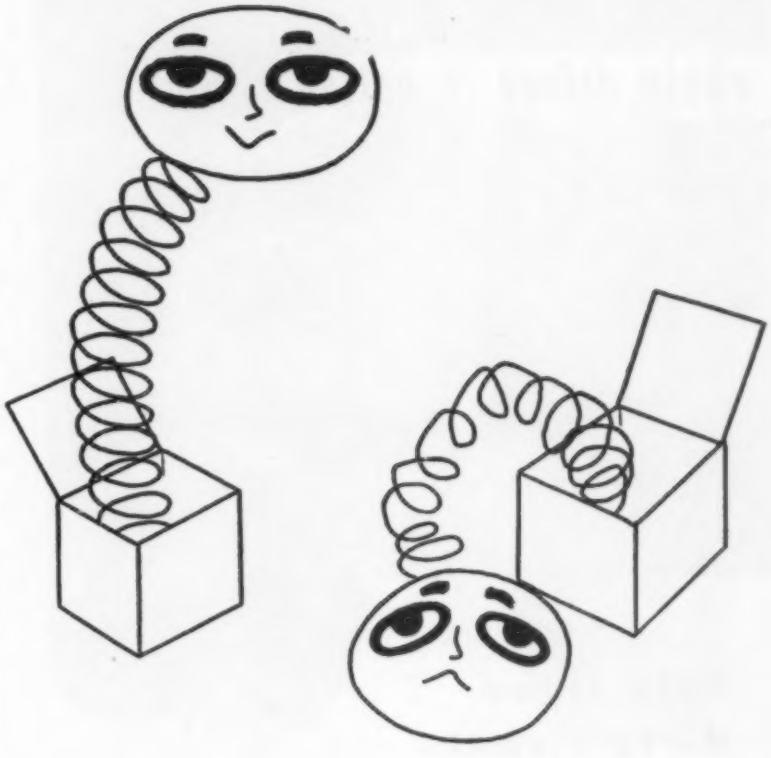
The tendency in contemporary mechanical engineering, according to this report, is toward reducing weight with respect to output by increasing revolutions in an engine, an increase which causes intensified engine vibration and noise by resonance of the engine housing. The report describes effective "suppression" of noise and concussion (as distinct from "damping" of vibration) through correct use of rubber-to-metal bonding. Shock absorption also is attained with supercritical mountings.

Calculus Refresher For Technical Men

A. Albert Klaf, *Civil Engineer,* 5½ x 8 *in., paperbound, 421 pp. Published by Dover Publications, Inc., New York.* $1.95.

This book is a quick refresher for engineers, technicians and students who either wish to brush up their calculus or who find parts of calculus unclear. It covers most of important

(Continued on page 409)



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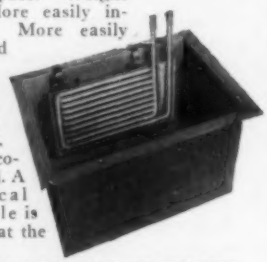

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Mechanical Engineering Laboratory Instrumentation

JESSE SEYMOUR DOOLITTLE, *N. Carolina State College*, 6 x 9 *in.*, 389 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $6.50.

This text is for a first course in mechanical engineering laboratory work, to acquaint the student with the various types of instruments for measuring quantities frequently encountered in the mechanical engineering field. The use and limitations of these instruments are stressed, as well as the care required in installing them to obtain correct measurements.

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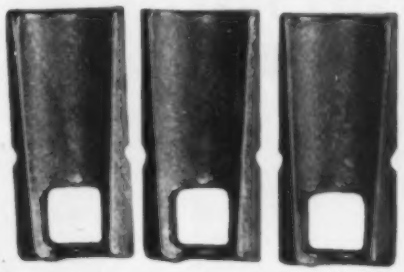

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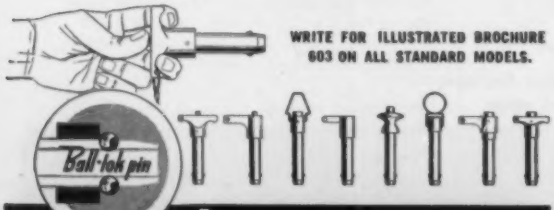

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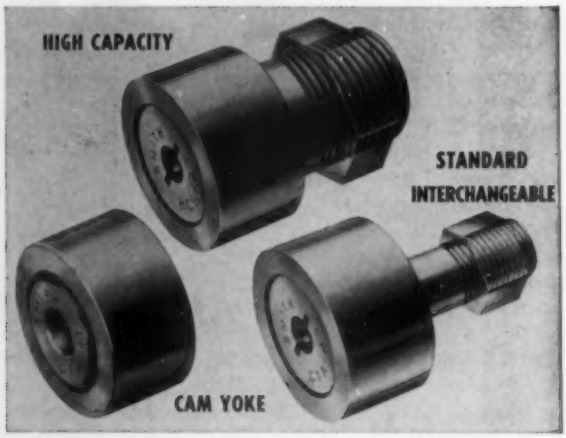

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OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Engineering Licenses for Corporations?

To the Editor:

The Ethics and Practices Committee of the Oakland Chapter, Michigan Society of Professional Engineers, has reviewed your editorial in the November issue, regarding the practice of professional engineering by corporations. You are to be highly commended for your statement that to license corporations would be a step in the wrong direction.

Whereas in Michigan, corporations do provide professional engineering services, all officers, directors and partners must be registered. As such they use their personal seals and assume responsibility. To license a corporation instead of the individual would permit the hiring of untrained, incompetent individuals—with the corporation assuming responsibility.

Since corporations are liable only to the extent of their incorporation value, severe loss could be involved if damages should accrue. This is the situation now with manufactured products, for which also, in our belief, competent and registered engineers should be responsible.

We would like to quote from your editorial in our chapter's bulletin and in the "Michigan Professional Engineer", if we may have your permission.

We feel that the healthy growth of engineering depends upon improved legal aspects as well as ethics.

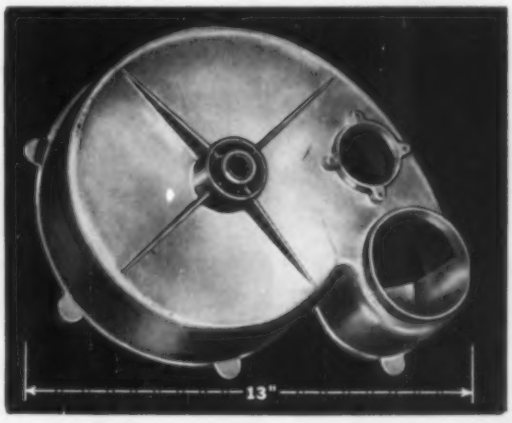
—Lawrence S. Le Gros
Birmingham, Mich.

Design Show Prohibits Recruiting

To the Editor:

Apropos your much-needed editorial, "Raiding Isn't Recruiting", I think you and your readers will find the recent decision of the management

(Continued on page 413)



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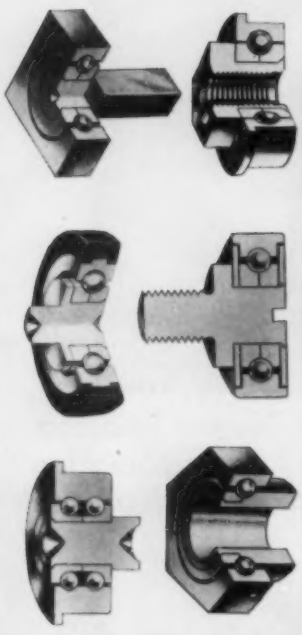

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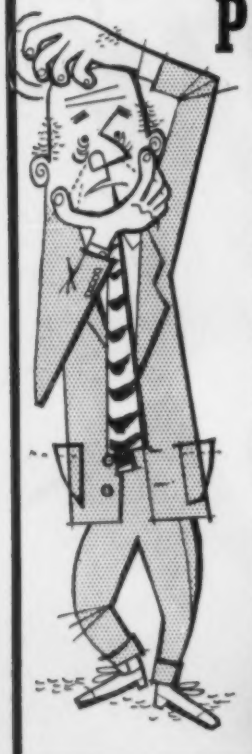

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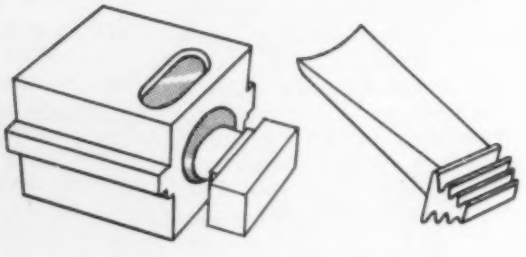

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of the Design Engineering Show of considerable interest. The rules governing the Show have been amended, as follow: "Exhibitor shall not have in his booth any displays, signs, literature or related media that refer to or describe employment opportunities in exhibitor's establishment."

Exhibitors—as well as those companies whose engineers are expected to attend—will undoubtedly agree that if the show is permitted to become a medium for trading employees, its value will be progressively lessened.

SAUL POLIAK
New York, N. Y.

Fiber a Converted Cellulose

To the Editor:

There is an error in the definition of fiber in the article, "Fiber-Base Structural Materials", page 164, Feb. issue. It is stated that fiber is a cellulose material. Cellulose acetate is a thermoplastic and softens under heat, which vulcanized fiber cannot do.

—G. M. LANG
National Vulcanized Fibre Co.
Wilmington, Del.

Ed—We regret this error, particularly because it was so obvious.

Ownership of Patents

To the Editor:

Recently, my attention has been called to the article "Fluidized Plastic Coatings for Corrosion Resistance," which appeared in the January issue of *Product Engineering*. The subject matter of this article is particularly familiar to me, since we hold an exclusive license in this country on the process described. Actually, the technique of fluidized bed coating was invented by Erwin Gemmer, of the firm of Knapsack-Griesheim A. G., in Frankfurt, Germany. Patents on this process have been issued in Germany, France, Italy and Great Britain. A considerable number of patents covering various aspects of the process are on file in this country.

It so happens that Polymer Processes, Inc., a wholly-owned, patent-holding subsidiary of Polymer Corp. obtained from Knapsack-Griesheim A. G. an exclusive license on this process in this country. I am very

(Continued on page 415)

Ruthman Gusher

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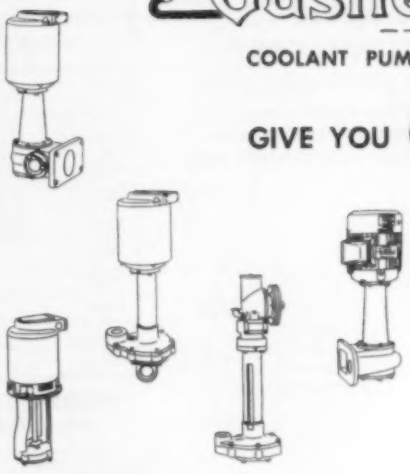

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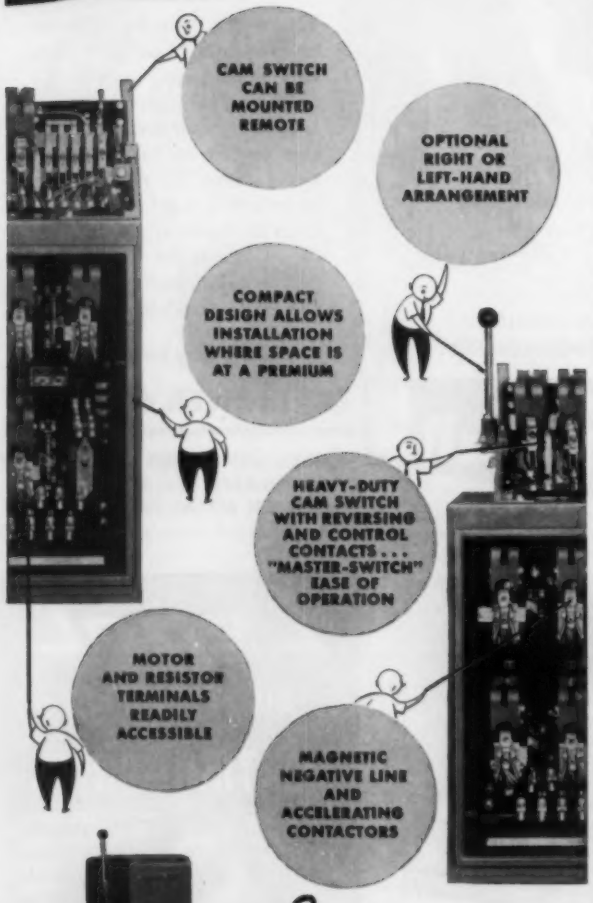
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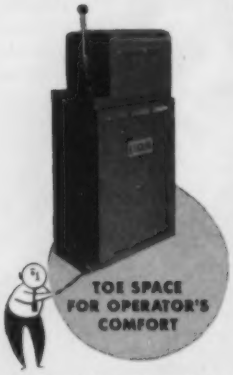

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Light Metals Design Tips

Relative Weights of Structural Metals

Material	Specific Gravity	Relative Weight	Weight lb/cu in.	Weight lb/cu ft.
Magnesium alloys	1.8	1.0	0.065	112
Aluminum alloys	2.8	1.6	0.101	175
Zinc	7.1	3.9	0.256	443
Cast iron	7.2	4.0	0.260	450
Tin	7.3	4.1	0.264	456
Steel	7.9	4.4	0.285	493
Brass	8.5	4.7	0.307	531
Bronze	8.8	4.9	0.318	550
Nickel	8.9	4.9	0.322	556
Copper	8.9	4.9	0.322	556
Lead	11.3	6.3	0.408	706

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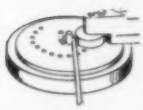
HOW TO BEND BARS and TUBING

HOW TO BEND . . .

OFF CENTER EYES

1. Insert bar stock between Locking Pin and Radius Pin of desired size.



2. Set Forming Roller against material and advance Operating Arm.

3. Complete operation with one steady movement.

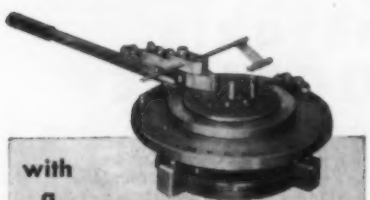
HOW TO BEND . . .

TUBING

1. Clamp tube. Insert Follow Block between material and Forming Roller.

2. Advance Operating Arm until it strikes Angle Stop.

3. Remove Follow Block, release clamp and remove tube.



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much afraid that the article appearing in *Product Engineering*, by omitting these facts, gives an erroneous impression on the whole subject.

—Louis L. Stott, Pres.
Polymer Corp.

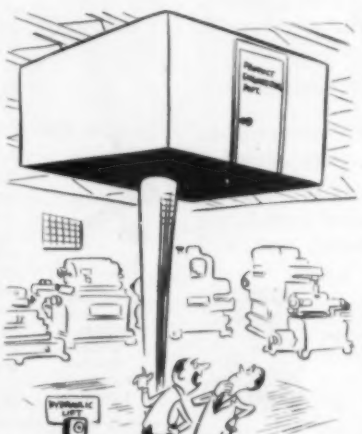
Westinghouse's Birthplace

To the Editor:

You may be interested in knowing the person doing research on the article on page 5 of your Feb. issue apparently made an error. It is stated that George Westinghouse was a young Vermonter. This does not seem to be right, as he was born in Central Bridge, N. Y., and grew up with his family in Schenectady.

None of the standard reference books tells of his living in New England for any period of time. The story about the invention of the air brake seems to follow the published reports very closely, and it makes a good introduction to the article on air motors in the same issue. —R. H. Koehler
Pittsburgh, Pa.

Ed—The source used by our researcher did give Vermont as Westinghouse's birthplace. However, as Mr. Koehler points out, most references do give the New York location.



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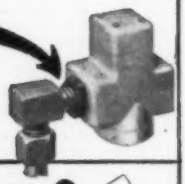

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TRU-O-SEAL Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.

$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread TRU-O-SEAL Fittings.

$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread TRU-O-SEAL Fittings.

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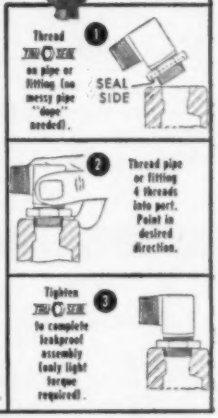
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.


1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into port. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

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Costs only a few dollars—adds many dollars in equipment value.

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Provision for fast, accurate operator "seeing" efficiency is vital in machine tool design. Fostoria Localites provide instantly controlled, high intensity precision lighting of the work area zone. Frictional arm and collar disc joints give flexibility of a thousand positions to direct light exactly as needed. Ruggedly constructed with heavy duty industrial socket, Levolier switch and SPT-2 18/2 rip cord wiring. Reflector types and arm lengths to suit any application. Request full information.

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PRESS PREVIEWS

Nuclear Research Laboratory

A nuclear research facility will be built by Industrial Reactor Laboratories, Inc., Plainsboro, N. J., under direction of AMF Atomics, Inc., subsidiary of American Machine & Foundry Co. who will also be responsible for supplying the nuclear research reactor. The building will consist of a one-story reinforced concrete administrative and experimental laboratory building, 168 ft x 188 ft; a dome-shaped reinforced concrete reactor building, approximately 90 ft in dia and 85 ft high; plus a utility building. The building which will house the reactor will be connected to the experimental laboratory by passageways containing radiation monitoring checks for personnel. Work will start in the near future and the entire job is scheduled for completion prior to July 1958.

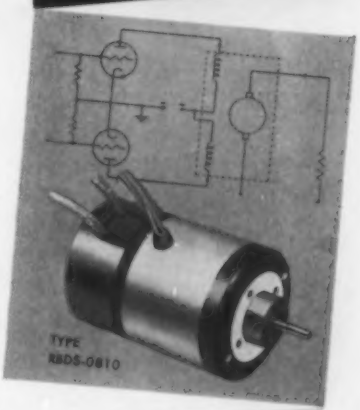
Synthetic Fibers Being Applied at Du Pont's Newport Laboratory

Du Pont's $2 million Industrial Products Research Laboratory, Newport, Del., recently played host to a gathering of editors from various technical publications. The laboratory, which contributed much of the basic knowledge that led to the use of nylon tire cord, has been actively developing new uses for papers and reinforced plastics made with synthetic fibers. Commercial production of paper is foreseen within a year.

(Continued on page 419)

HOLTZER-CABOT

D. C. Miniature Servo-Motor



Holtzer-Cabot's Type 0810 is well known for its precision performance in gun fire control, radar navigation and radio tuning. It features immediate response to minimum input signal. The armature is designed for continuous excitation from a 24 to 29 volt D.C. source through a 28 ohm series resistor. The field has two 10,000 ohm sections: one for C.W. and the other for C.C.W. rotation. Full rated motor output is obtained by 6 ma. differential field current.

SPECIFICATIONS: Rating 0.3 oz. in., 6500 R.P.M., .002 H.P.; Diameter: 1⅝"; Field Current 6.0. Milliamps: Armature Current 0.4 amp., Duty Cycle: 4 reversals per minute; Altitude: 50,000 feet; Amb. Temperature: −65° C to +72° C. Designed to meet Mil. specs. Send coupon below for additional information.

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: ☐ Please send me data sheets on the Holtzer-Cabot Type RBDS-0810 servo motor.

☐ Please have representative call on ..... (date)

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Company.....

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City.....Zone....State.....

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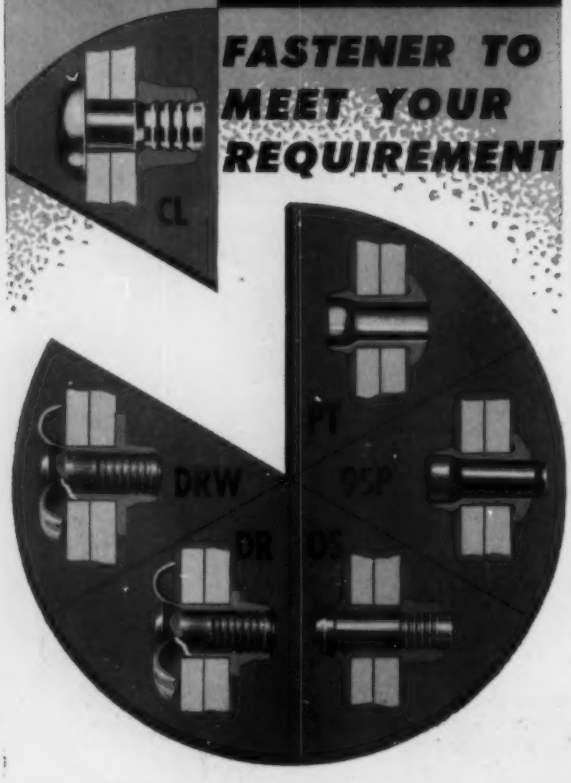

Hundreds of manufacturers here and abroad have found the answer to their toughest fastening problems in HUCK'S complete line of commercial, positive-locking rivets.

Huck fasteners are available in many sizes and shapes to meet the many specialized requirements of industry, from railroads to electronic fabrication. Their fast, simple application and positive locking features save production dollars, time and trouble for their many users—producing a better fastening job.

Write or call for a HUCK sales engineer to discuss your problems. There's no obligation.

U.S. Patent numbers 2531048, 2531049, 2754703, 2527307 and patents applied for.

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PROTECT your expensive gages from damage with Republic Gage Protectors and Pressure Snubbers.

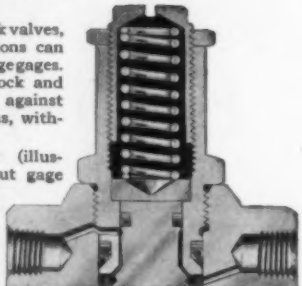
Fluid hammer, chattering check valves, and severe pressure fluctuations can cause extreme shock, and damage gages. Pressure Snubbers absorb shock and permanently protect gages against damage from wild fluctuations, without affecting accuracy.

Adjustable Gage Protector (illustrated) automatically cuts out gage when system pressure rises above gage range, and reopens when pressure drops.

Two types—ranges 15 to 5000 psi; 3 to 50 psi.

Working pressures to 10,000 psi.

Ask for catalog 654A.



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In addition to a full complement of instruments common to most properly equipped fiber research laboratories, specialized test equipment is available. An example is a special device for simulating the flexing action that cord undergoes in a tire. This unit determines fatigue resistance of tire cord by recording the number of twists sustained by a short length of hose reinforced with the cord before it ruptures and allows escape of air compressed within it.

A tire is built to test each new idea of construction. Some are road tested; others go on the test wheels (shown p. 419) to duplicate selected conditions of tire service. Tires can be run at speeds up to 120 mph, under varying loads. One fairly standard test involves starting a tire at 60 mph in a temperature of 100 F, running for 2 hr, increasing the speed to 75 for an hour, then to 80, to 85, and on up, with an hour at each level until the tire fails.

Stanat Expands Nuclear Division

The expansion of the Nuclear Division of Stanat Mfg. Co., Inc., Westbury, N. Y., is scheduled for completion early this spring according to company officials. The company supplies rolling mills, gang slitters and roller levelers designed for remote operation in "hot" areas and in inert atmospheres.

Electrical Connector Company Expands

Burndy Corp., Norwalk, Conn., a manufacturer of electrical connectors, has begun four major construction projects as part of a $2¼ million expansion program. A 63,000 sq ft addition to the company's plant in Milford, Conn., will be completed this fall at a cost of $600,000. This will be the major manufacturing facility of the company's Omaton Division, serving producers of electrical, electronic, and military equipment. At the Norwalk plant, two segments of the program are now under way, one a $500,000 warehouse, the other a $250,000 addition to house expanding

(Continued on page 421)

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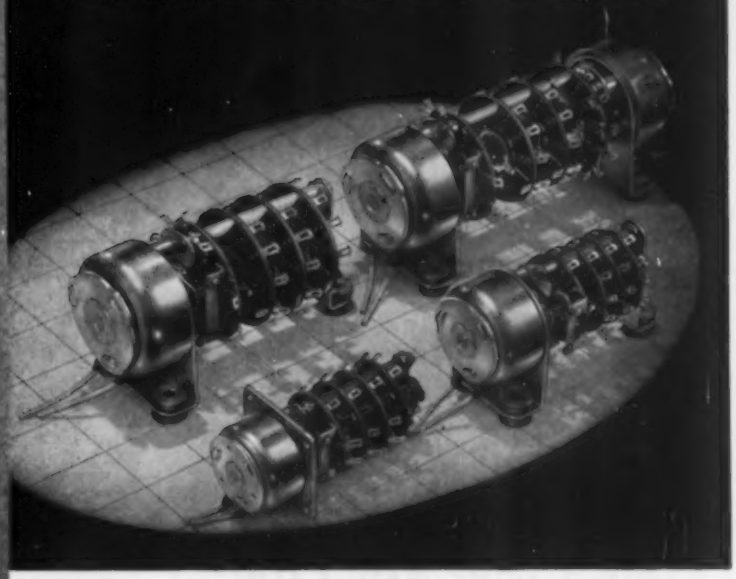
WILL HELP YOU SIMPLIFY REMOTE SELECTION of CIRCUITS!



A few examples of standard Model, Ledex relays. Use the 1" squares in the background to estimate size of the relays.

Ledex Relays are available to perform a variety of switching jobs... STEPPING...COUNTING...ADDING AND/OR SUBTRACTING...PROGRAMING... CIRCUIT SELECTING...and HOMING.

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Year after year —Get steady, positive

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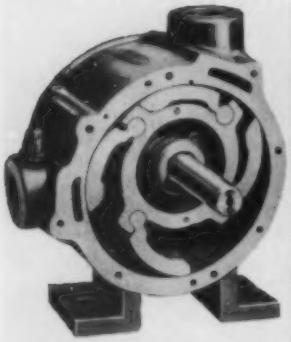
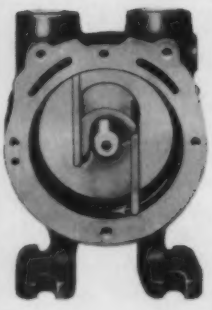


4-WING TYPE. Vacuums to 20" Hg.; pressures to 15 lbs.; displacement to 162 c.f.m. Wings hinged to pistons maintain continuous sealed contact with cylinder walls by centrifugal force. Small pistons, large air chambers, greater capacity.



2-WING TYPE. Vacuums to 29.9" Hg.; pressures to 20 lbs.; displacement to 40.8 c.f.m. Automatic wing adjusting lever forces wear-resistant steel blades to cylinder walls, preventing sticking or binding, maintaining positive vacuum or pressure.

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LEIMAN *Rotary* AIR PUMPS

New!
Air-cooled High Vacuum Pump
Vacuum to 29.9" hg. 15 to 40.8 c.f.m. Operates at 140°F. Write for folder.

Other types:
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- Double Cylinder Type
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When you design a machine to operate with specific vacuum, suction or air pressure—specify Leiman Air pumps to be sure of fully-rated capacity for the life of your equipment. Forget about customer complaints, shutdowns or service calls due to air pump trouble.

Leiman Air Pumps are designed and constructed to take up their own wear—provide leakless wing-to-wall seal for years and years. Fewer moving parts—no tips or blades to renew—no maintenance except occasional oiling. Over half a million installed. Representatives and engineering assistance available in all industrial centers. Tell us your needs.

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The "Lifetime" Pumps that take up their own wear
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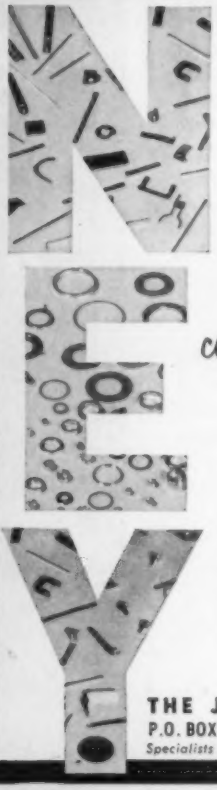
NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



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1. When application is for: Blower type electric unit heaters, duct heating, unit convection heating, as oven or space heaters in dryers, pump rooms, switch towers, etc.

2. When specifications call for: Steel sheath for sheath temperatures to 750°F; Chromalloy sheath for sheath temperatures to 1200°F; length — 10½" to 42½" (or higher); wattage — 500 to 3250 (or higher); voltage — 115 or 230; rugged non-oxidizing terminal posts.

3. When you have "hot" problems: Vulcan Engineers are ready to provide special heating units — engineered to *your* needs.

***NEW* FINNED TUBULAR HEATERS**

Vulcan's new Finned Tubular Heaters provide six times as much radiating surface as standard tubular heaters. Fin is spirally edge wound from continuous strip of steel, then silver brazed to surface of sheath. Heaters can be formed at factory into one or a series of hairpin bends.

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Cartridge • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

service and short-run manufacturing operations. In Toronto, Burndy Canada, Ltd., a wholly-owned subsidiary, is constructing a $700,000 office and manufacturing building to meet the needs of the company's Canadian business.

New Laboratory for Developing Miniature Gyros

To develop new miniature and subminiature gyroscopes for military and commercial aircraft, Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America, has completed a half-million dollar research and production facility at its Roosevelt Field, N. Y., plant.

David T. Bonner, President, stated that the Reeves Laboratory is already producing floated gyroscopes and accelerometers in 1, 2 and 3½ in. dia, with components made to tolerances as close as 0.00001 in. A line of smaller and more accurate models of these instruments is under development.

Physical Testing Laboratory For Steel

A million-dollar physical testing laboratory will be built by the Lukens Steel Co., Coatesville, Pa., producer of specialty steel plate. The building and related facilities are scheduled to enter full operation in about a year.

New Cellophane Plant

This spring, the du Pont Co. plans to start a new cellophane plant near Tecumseh, Kan., to be operated by the Film Dept. The plant which will produce 50 million lb of cellophane yearly is expected to go into operation early in 1959. It will provide about 600 operating jobs, and will cost well into eight figures.

Steel Company Completes Electrification Program

Completion of the conversion from steam drive to electrical operation of the Phoenix Iron and Steel Company's 126 in. plate mill at Harrisburg, Pa., has been announced. The

(Continued on page 423)

The Clentimack transmission is a variable speed transmission for the control of any process or machine requiring variable speed. Adjustments may be made manually or automatically over a complete range 8.1 — while the unit is at a standstill or in motion.

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VARIABLE SPEED TRANSMISSION

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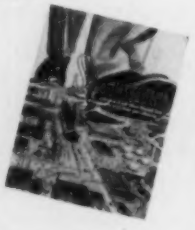
Rubber parts capable of withstanding temperature extremes eliminate many costly metal fabrications forced on design engineers because of the limited thermal stability of organic rubbers.

Stalwart is prepared to work with design engineers in the development of compounds as well as shapes to meet specific requirements. Whether your specifications involve extruded, molded, die cut or mandrel cut parts . . . check FIRST WITH STALWART!

Write today for your copy of SR-56-3



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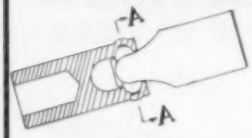
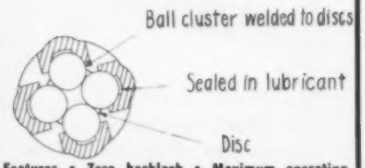
MINI-JOINTS*

*Miniature Universal Joints with ZERO BACKLASH

for greater freedom in instrument design





Features • Zero backlash • Maximum operating angle of 30° • Lightweight • Sealed-in Lubrication

DIMENSIONS

Part NO.	ID	OD	OL	WGT.
SBS	SOLID	3/16	1-1/32	
1BS	.0938	"	"	.005
2BS	.125	"	"	"
3BS	.156	9/32	1-3/8	.013 #
4BS	.1875	"	"	"
5BS	.2188	3/8	1-3/4	.031 #
6BS	.250	"	"	"

(Also available as double joints)

Send for further information . . . available promptly on request.

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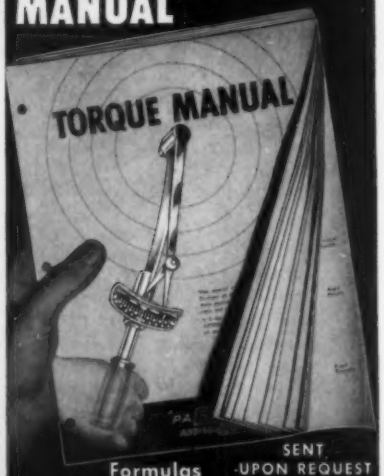
"TORQUE WRENCH" MANUAL



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plant has also been expanded with the installation of a new open hearth furnace with an estimated capacity of 75,000 tons per yr. Electrification, combined with certain mill improvements, makes possible the rolling and shearing of steel plate up to 12,500 lb. Plant ingot capacity has been increased to approximately 500,000 tons annually.

Radiation Manufacturing And Test Facility In Operation

High Voltage Engineering Corp., formerly of Cambridge, Mass., will manufacture its Van de Graaff and linear particle accelerators in an 88,000 sq ft plant in Burlington, Mass. The facility contains enough radiation test vaults to allow operation of 16 accelerators simultaneously. Each vault has been designed to provide the maximum level of protection from radiation, both inside and outside the plant. Each has concrete walls 4 ft thick, with a 20-ton concrete block door mounted on trucks which ride on specially built-in rails. Also available for experimental radiation programs is one of the company's Van de Graaffs for use by industry in pilot studies of electron sterilization, polymerization, cross-linking and other radiation processing applications.

The new facility cost nearly $2-million, a figure which includes specialized production and test equipment. Manufacturing area occupies nearly one-half of the plant, with remaining space di-

(Continued on page 425)

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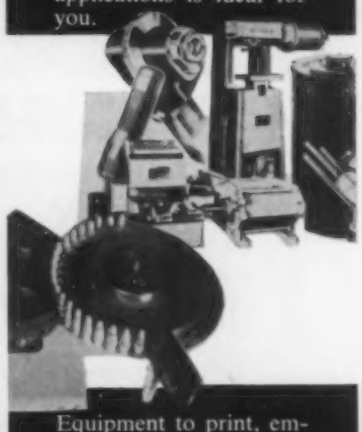
By incorporating a Matthews' Marking Station in your processing. Whether your product is round, contoured or flat; metal glass or plastic . . . one of Matthews' Marking applications is ideal for you.



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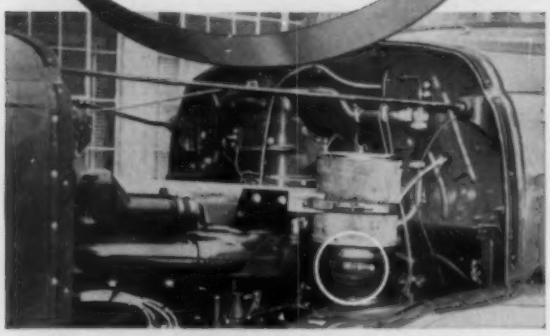
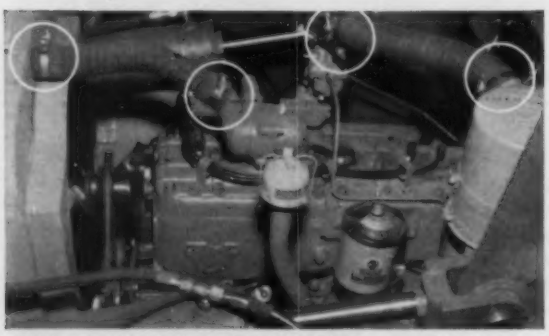
Marman 820 Series Universal Clamp features smooth, flexible band design for quick, easy installation on *any shape* hose or duct. Exclusive self-locking swivel nut assures positive seals, yet reusable clamp opens easily to speed disassembly and assembly. Stainless steel construction. Sizes from 1 1/16" to 22 1/8" in diameter.



For easy servicing, the air filter on this truck engine is equipped with Marman Universal Clamps.



Quick, easy installation plus high performance make Marman Universal Clamps ideal for large engine hose.

Write for Engineering Bulletin No. A2551-510

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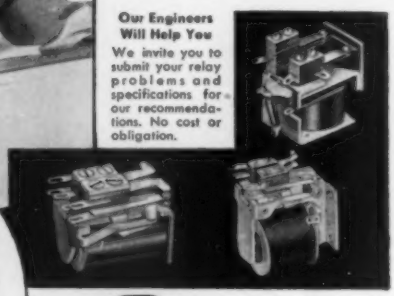

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vided between test, engineering and research; executive and administrative offices, chemical and electronic laboratories; dark room and service departments.

The Van de Graaff generator (pictured p. 423) has found applications in the preservation of foods, sterilization of drugs, initiation of chemical reaction and the cross linking of plastics to improve such characteristics as strength, temperature resistance and insulating properties. This specific application is discussed in greater detail in the report on irradiated materials, page 167.

Pipe and Tubing Plant For West Coast

Trend Tube Co., East Troy, Wis., has completed plans for opening a plant to manufacture welded stainless steel and high alloy tubing and pipe. The new plant will be located at Fullerton, Calif., and is scheduled to be completed and ready for operations by mid-1957. The plant will operate as a division of the company's main Wisconsin works. Supervisory employees will be moved from East Troy and new employees will be hired locally to fill the requirements of the new operation.

West Coast Plant for Control Systems

A West Coast manufacturing plant has been opened in Alhambra, Calif., by Panellit, Inc., Skokie, Ill. The new plant will provide sales, engineering and construction service for instrument control centers. The company designs and fabricates control systems, data reduction systems, and annunciators.

New Divisions

Creation of a Detroit Manufacturing and Engineering Div. within the Burroughs Div. of Burroughs Corp. has been announced by the company. About 6000 persons are employed in the Detroit Division.

Westinghouse Electric Corp., Pittsburgh, Pa., announced the formation of a new division to be known as X-Ray and Industrial Electronics Div.

(Continued on page 427)

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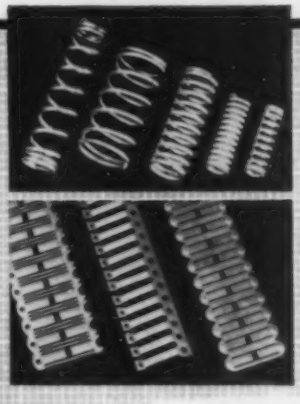

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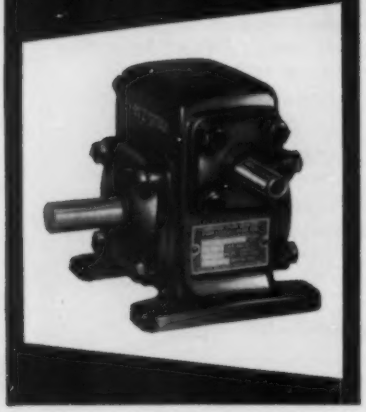

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The group will be located in Baltimore, Md.

Vanadium-Alloys Steel Co., Latrobe, Pa., has established a Metallurgical Product Development Group to handle the problems associated with the complexity of product development.

An applied mechanics engineering group has been formed at General Electric's Metallurgical Products Dept., Detroit. The new specialized unit will be responsible for obtaining basic information on physical properties, machinability, fundamental application requirements; and for performing stress analyses to guide material development. It also will help establish design and application criteria.

Name Changes

Stanford Laboratories Co., Menlo Park, Calif., has changed its name to Geisler Laboratories. The facility is presently concerned with microwave physics.

The Continental-Diamond Fibre Division of the Budd Co., Inc., Philadelphia, Pa., has been changed to the Continental-Diamond Fibre Corp. The corporation will remain a wholly owned subsidiary of the Budd Co.

Logistics Research, Redondo Beach, Calif., has changed its name to Alwac Corp., the company manufactures electronic data processing systems.

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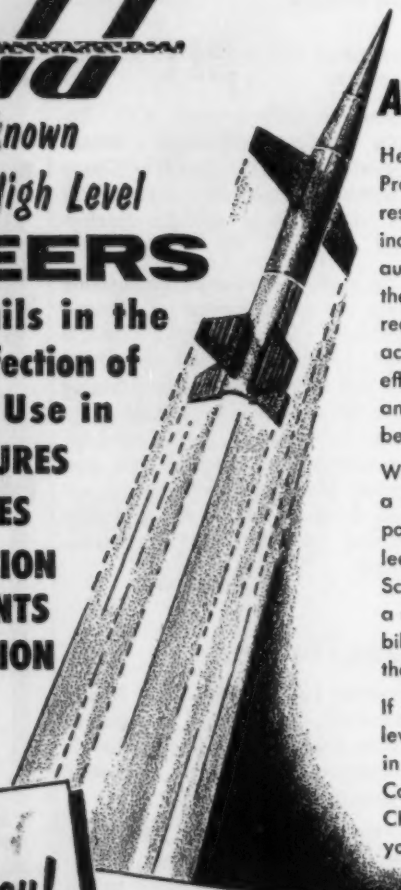

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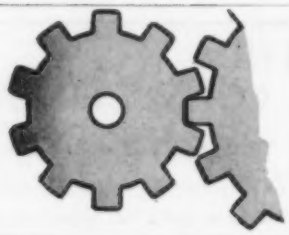

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Index of

PRODUCTS ADVERTISED

In This Issue

A

Accumulators 121

Actuators
Mechanical 37

Adhesives 46-47

Air Motors (see Motors, Air)
Aluminum Alloys ..2, 50-51, 107-108, 321

Aluminum Coated Sheet and Strip
(see Steel, Coated)

Assemblies
Electrical 252, 445
Hydraulic 345
Pneumatic 305

Axles 315

B

Ball Joints 273

Balls 320

Bars
Metal 13, 60, 306

Bearing Materials 114-115

Bearings
Ball 70, 105, 134, 212, 223 229, 237, 300, 320, 349, 360-361 381, 412
Miniature 300
Needle 70, 219, 320
Roller 26-27, 70, 82, 105, 212 219, 223, 237, 300, 320, 360-361
Sleeve 74, 306, 433

Bellows 331

Belts, Timing 66

Belts, V 236, 332, 395

Benders 415

Bi-Metal 31, 347

Blowers 340

Bolts 35, 274, 348, 386, 400

Boosters 121

Brakes
Electric 265
Pneumatic 259

Brass 221

Brazing 50-51

Brazing
Alloys 372

Bronze 221

Brush Holders 445

Brushes 406, 420

Brushes, Electrical 445

Bushings 237, 306

Bushings, Strain Relief 427

C

Cabinets 342

Cam Followers 219, 410

Capacitors 8

Continued on p. 434

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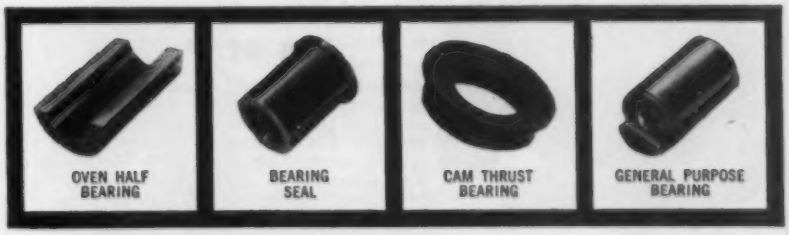

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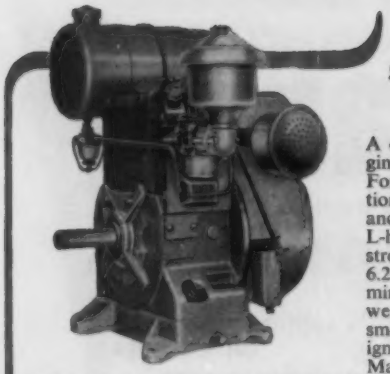

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Overall dimensions: *Length (incl. shaft) 15¼", height (with tank) 20", Width 20¼".* **Weight:** *(Dry with accessories) 86 pounds.* **Power take-off:** *Crankshaft extension 3¼" long, 1" diameter.*

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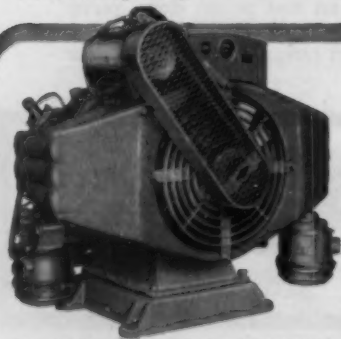

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Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 433

Carbide Alloys 88-89

Carbon Parts 433

Casters 357, 388

Castings 20-21, 234-235, 287, 367, 383, 409

Castings, Centrifugal 260, 344

Castings, Precision Investment..358, 376

Catalog Services 18-19

Ceramics .....273 A & B, 291, 402

Chains
- Conveyor 53, 116
- Roller 53, 74, 116, 312, 408
- Silent 53, 116

Chemical Treatments...261, 298, 330, 368

Chromium Alloys 113

Clad Metals 398

Clamps 132, 424

Cleaners, Metal 371

Clips, Electrical 376

Clutches
- Mechanical 242, 315, 354, 389, 446

Coatings 261, 284, 298, 330, 368, 402

Coils 408

Cold Headed Parts 348, 386, 442

Connectors
- Electrical 299, 370
- Hose 283, 295
- Tube 283, 295

Contactors 307-308

Contacts & Contact Materials ...420, 445

Controllers 414

Control Panels & Switchboards.....33-34

Controls
- Electrical 48, 92, 256, 307-308, 373
- Hydraulic 268, 345
- Mechanical 322
- Pneumatic 268, 369

Conveyor Belts 328, 395

Copper & Copper Alloys.....221, 344

Cords 276

Counters 17, 346

Couplings (see Connectors, Electrical)

Couplings
- Hydraulic 394, 402
- Mechanical 74, 389

Cylinders
- Hydraulic 121, 268, 285, 311, 394
- Pneumatic 121, 268, 285, 311, 369

D

Decalcomanias 427

Die Castings 81, 250-251, 289, 310, 335, 411, 417

Dies 234-235

Index of

PRODUCTS ADVERTISED

In This Issue

•

Differentials 315

Dimmers 373

Drafting
Instruments 314
Machines 103
Supplies 103, 248, 370, 418

Drives
Adjustable Speed 96-97
Hydraulic 360-361
Right-Angle 334
Variable Speed, 3rd Cover, 15, 272, 303 364, 385, 421

E

Electrical & Electronic Components, Custom Made (see also Production Services) 252, 339

Electrochemical Finishes & Treatments 284

Engineering Services (see also Production Services) 66, 317

Engines 68, 73, 318, 434

Expanded Metals 326

Expansion Joints 32

Extrusions
Metallic 2, 321, 344
Non-Metallic ...275, 291, 406, 412, 422

F

Fabricated Plastics (see Plastics, Fabricated)

Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)

Facings, Clutch 377

Fastening Methods 45, 112, 132 233, 247, 282, 404, 418, 442

Felt 294, 408

Fibre 280, 325

Filters
Air 305, 380, 400
Hydraulic 241, 350, 380

Fittings, Hose, Pipe & Tube.....283, 295 375, 391

Flexible Couplings 116, 408

Flexible Shafts 338, 401

Floats 58

Forgings 93, 114-115, 231 341, 344, 351

Friction Materials 377, 395

Furniture, Engineering Dept. 334

G

Gaskets 41

Gear Motors (see also Motor Reducers).....3rd Cover, 15, 22-23, 364

Gears 1, 59, 74, 94, 238, 244 278, 290, 293, 426, 435

Generators
A-C 315
D-C 315

Glass 263

Continued on p. 436

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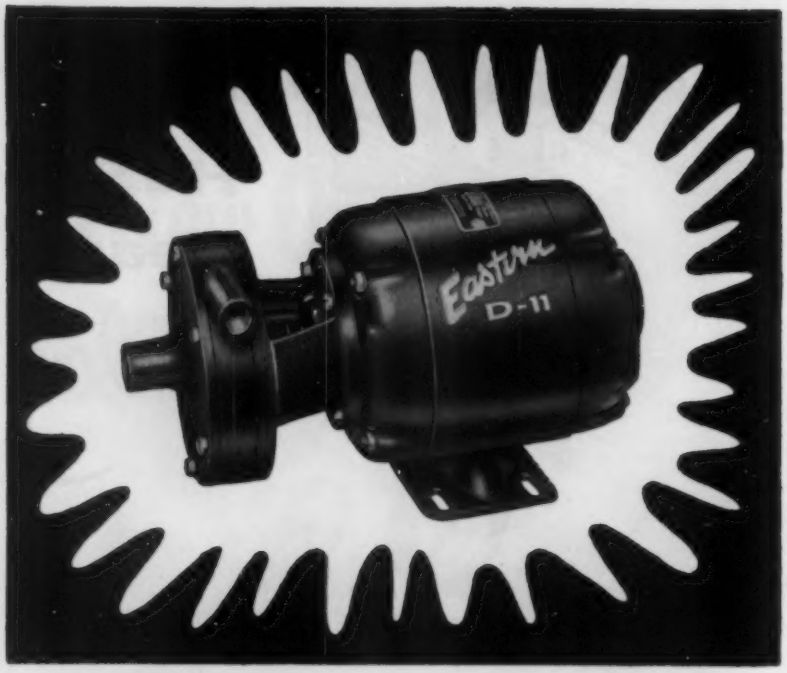

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Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 435

H

Handles & Knobs 444
Hard Surfacing 416
Heat Exchangers 242
Heating Units 384, 413, 415, 421
High Temperature Alloys 36, 125
Hoists 286
Hose & Tubing 75, 295, 375
Hydraulic Fluids 84-85, 106

I

Indium 279
Insulating Varnish 83
Insulation 83

J

Jacks 286

L

Lamps, Indicating 416
Laminated Plastics (see Plastics, Laminated)
Latches 243
Linings, Brake 377
Low Temperature Melting Alloys... 412
Lubricants 106, 330
Lubricating Equipment 123, 128, 253, 305

M

Magnesium Alloys 86, 414
Magnetic Materials 88-89
Magnets 88-89, 302
Manganese Alloys 113
Marking Machines & Tools 423
Metal Bonded to Plastic 78
Metal Forming 50-51
Moldings
Glass (see Glass Parts)
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Motor Starters 92
Motors, A-C
Fractional, 3rd Cover, 22-23, 42-43, 62-63 96-97, 101-102, 109, 214, 303, 313
Integral, 3rd Cover, 22-23, 96-97, 101-102 214, 303, 313, 364
Sub-Fractional 379
Motors, Air 343
Motors, D-C
Fractional 22-23, 42-43, 62-63 96-97, 101-102, 109, 214, 303

Index of

PRODUCTS ADVERTISED

In This Issue

•

Integral 22-23, 96-97, 101-102 214, 303, 364
Sub-Fractional 379, 417
Motors, Hydraulic 71, 343
Mountings 327

N

Name Plates 427
Nuts 35, 45, 80, 87, 132 243, 376, 384, 386, 394, 400, 414

P

Packings 41, 84-85, 404, 441
Paper 443
Perforated Metals 378
Pillow Blocks 105, 360-361
Pilot Lights 33-34
Pins 87, 404, 410
Pipe 60
Plastic Parts 275, 310, 339 390, 412, 437
Plastics ...38-39, 49, 67 A & B, 90-91, 124 130, 266, 292, 329, 363, 437
Plastics Fabricated 275, 280 325, 390, 437
Plastics Laminated 78, 258, 280, 325
Plugs 299
Potentiometers 316
Powdered Metal Parts, 4th Cover, 119, 289 306, 356, 390
Power Packs Hydraulic 345, 394
Power Take-offs 315, 354
Precious Metal Alloys 420
Production Machines & Processes... 415
Production Services (see also Engineering Services) 252, 320, 339
Pulleys 403
Pumps
Air 343, 380, 420
Liquid 67, 71, 101-102, 277 343, 380, 397, 413, 436
Vacuum 380, 420

R

Recorders 359
Regulators
Hydraulic 353
Pneumatic 305, 353
Relays 33-34, 44, 76-77, 210 307-308, 373, 374, 419, 424
Reproduction Equipment 103, 314
Reproduction Supplies 54-55 103, 248, 314
Resins .....38-39, 64, 67 A & B, 83 126, 292, 329

Continued on p. 438

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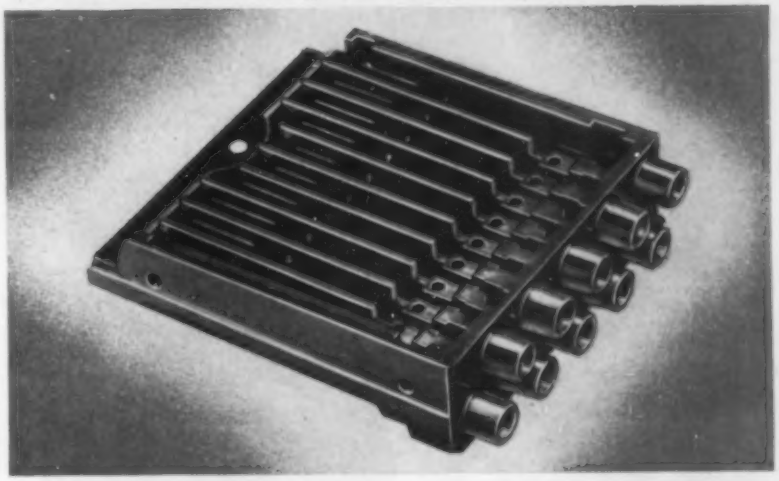

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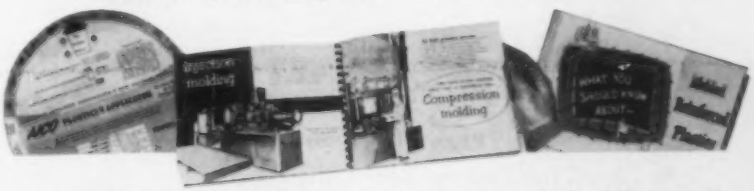

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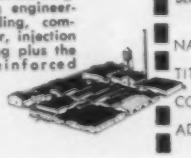

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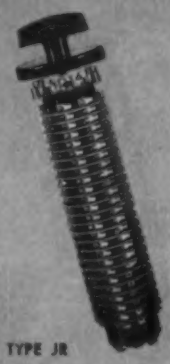

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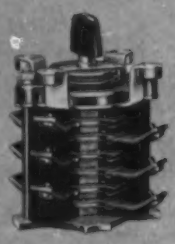

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Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 437

Resistors 120, 373
Retaining Rings 61, 423
Rheostats 373
Rivets 45, 243, 418, 442
Rod Ends 56
Rods
Metallic 114-115, 394, 407
Non-Metallic 275
Rubber 16, 32, 225
Rubber-Bonded-to-Metal 327
Rubber Parts, 2nd Cover, 395, 412, 422
Rust Proofing 330

S

Scales 390
Screw Fasteners 243
Screw Machine Parts 273
Screws 35, 52, 100, 127, 227 274, 348, 376, 384, 386, 442
Seals 41, 72, 257 297, 337, 396, 404, 416
Seating Work Equipment 410
Servomechanism Components 386
Shapes, Rolled Formed 50-51, 309, 356
Sheets
Metal 60, 296, 398
Plastic 275
Shims 264
Silicones 239-240
Silver Alloys 372
Solenoids 386
Spacers 356
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.), 45, 112 132, 227, 233, 243, 274, 282, 336 348, 384, 394, 400
Speed Reducers 59, 74, 94, 278 293, 354, 360-361, 426
Splines 37
Springs 254-255, 370, 402, 425
Sprockets 53, 74, 116, 312, 408
Stampings 50-51, 315, 339, 370
Steel
Alloy 28-29, 98-99, 104, 267
Coated 57
Stainless 24-25, 60, 98-99 113, 245, 296, 367
Strainers 380
Strip, Metallic 60, 296, 394, 398, 407
Structural Forms & Shapes 309
Studs 348, 398-399
Switches 30, 33-34, 95 281, 387, 400, 438
Swivel Joints 355

Index of

PRODUCTS ADVERTISED

In This Issue

•

T

Tapes, Insulating (see Insulation)... 280
Terminals & Terminal Boards 323
Testing Machines & Equipment 440
Thermistors 88-89
Thermostats 11, 14
Timers 118, 399, 406, 411
Titanium 24-25, 317, 352
Tools 422
Torque Converters 110, 242, 315
Tracing Paper 54-55, 418
Transmissions 315, 421
Tubing
  Flexible Metal 75
  Lock-Seam 319
  Plastic 275
  Rubber 262
  Seamless 24-25, 65, 288, 362, 365, 394
  Welded 2, 69, 79, 288, 301, 362
Tungsten Carbide 88-89

U

Universal Joints 234, 315, 324, 422

V

Valves
  Air 6, 117, 246, 268, 305, 333, 353, 366, 418
  Control 333
  Hydraulic 6, 71, 117, 268, 353, 366, 394, 413, 418
  Solenoid 6, 117, 333, 366
Vibration Dampers
  Mechanical 327
Vibration Mountings 327
Vibrators 405
Vibratory Equipment 405, 440

W

Washers 384
Washers (see Packings)
Weldings
  Equipment 269, 304
  Supplies 269, 396-397
Weldments 50-51
Wheels 424
Wire 40, 60, 245, 339, 365, 404, 407
Wire & Cable 249
Wire Cloth 122, 328, 439
Wire Forming 370
Wiring Devices 276, 299, 342
Wiring Harnesses 252

Z

Zinc Coated Sheets 57
Zinc Coated Strip 57

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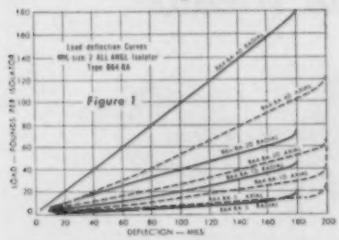
Isolator Requirements

Higher shock inputs require more stiffness in the isolator, to store more energy for a given deflection, so there will be less energy to dissipate if the isolator bottoms. *Higher vibration amplitudes* call for greater clearances and minimum transmissibility at resonance. And vibration protection *under high-g sustained acceleration* demands a combination of these characteristics.



Use of Performance Curves

The characteristics of an isolator having the stiffness necessary for handling the shock and sustained accelerations of jet and missile take-offs is shown by the curves of Figure 1. These curves can be used in choosing the proper isolator for operation under the expected service conditions, since they show both the deflection of isolators under a wide range of loadings and the maximum allowable deflection due to the combination of static load, sustained acceleration, and vibration amplitude.

A transmissibility at resonance well below three — considered exceptionally low — is shown by the curves of Figure 2. The measurements for these curves were made with a 27-pound load supported on four 10-pound isolators, with double-amplitude vibration input of 80 mils. These curves, showing performance for both base and bulkhead mounting, also indicate that the isolator satisfies the need for *consistent operation in every attitude* of flight, launching, and maneuvering.

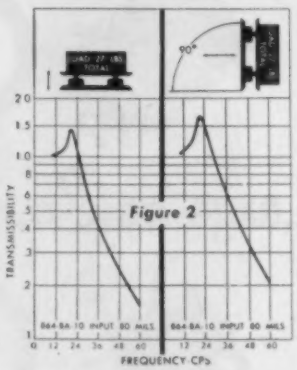


Figure 3 illustrates the construction of the B64 isolator that provides the performance characteristics shown by the curves, yet is dimensionally interchangeable with MIL-size mounts of comparable load ratings.

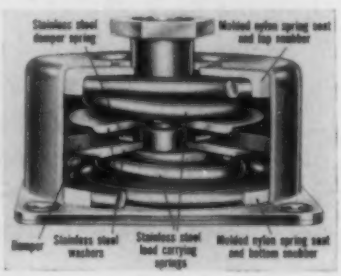

Stainless steel damper spring
Molded nylon spring seat and top washer
Damper
Stainless steel washers
Stainless steel load carrying springs
Molded nylon spring seat and bottom washer

Figure 3

Additional Design Data

Other curves of isolator characteristics, and data on their use in designing *for predictable environment in jets and missiles*, are contained in Barry Bulletin 57-2. This bulletin fully describes the complete line of ALL-ANGL Barrymount isolators in standard MIL sizes. Write today for your free copy.

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INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

A

AMP, Inc. 323
Acme Chain Corp. 312
Adams & Westlake Co. 210
Aeroquip Corp. 375
Aetna Ball & Roller Bearing Co. 237
Airborne Accessories Corp. 334
Air-Maze Corp. 400
Alemite 123
Allegheny Ludlum Steel Corp. 367
Allen-Bradley Co. 33-34
Allen Mfg. Co. 127
Allied Research Products, Inc. 368
Allied Wheel Products, Inc. 424
Allis-Chalmers Mfg. Co. 101-102
Allis Co., Louis 96-97
Aluminum Co. of America 247
American Brass Co. 93
American Chemical Paint Co., Metalworking Chemical Div. 261
American Cynamid Co., Plastics & Resins Div. ..... 67A & B, 292
American Gear & Mfg. Co. 244
American Insulator Corp. 437
American Latex Products Corp. 329
American Lava Corp., Subs., Minnesota Mining & Mfg. Co. 291
American Metal Hose Div., American Brass Co. 75
American Nickeloid Co. 398
American Steel & Wire Div., U. S. Steel Corp. 40, 60, 98-99
Amforge Div., American Brake Shoe Co. 351
Ampco Metal, Inc. 344
Apex Machine & Tool Co. 324
Apsco Products 370
Armco Steel Corp. 4
Arrow-Hart & Hegeman Electric Co. 307-308
Arwood Precision Casting Corp. 358
Associated Spring Corp. 254-255
Automotive & Aircraft Div., American Chain & Cable Co. 322
Automotive Gear Works, Inc., Subs. of Eaton Mfg. Co. 1
Autron Engineering, Inc. 346

B

Babcock & Wilcox Co., Tubular Products Div. 362
Bakelite Co., Union Carbide & Carbon Corp. 38-39
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 231
Barksdale Valves 6
Barry Controls, Inc. 440
Bearings Co. of America, Div., Federal-Mogul-Bower Bearings, Inc. 381
Bethlehem Steel Co. 267
Boston Gear Works 74
Bourns Laboratories 316
Bridgeport Brass Co. 221
Briggs & Stratton Corp. 73
Bruning Co., Inc., Charles 54-55, 103
Bundy Tubing Co. 319
Bunting Brass & Bronze Co. 306

C

Cambridge Wire Cloth Co. 328
Cameron Iron Works, Inc., Forge & Ordnance Div. 341
Cannon Electric Co. 299
Carpenter Steel Co. 125
Carter Controls, Inc. 268
Cash Co., A. W. 353
Central Foundry Div., General Motors Corp. 20-21
Century Electric Co. 303
Cerro De Pasco Corp. 412
Char-Lynn Co. 394
Chicago Molded Products Corp. 130
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Chiksan Co. 355
Chrysler Corp., Engineering Div. 388
Clapp & Poliak, Inc. 270-271
Clentimack Co., George E. 421
Cleveland Cap Screw Co. 348

INDEX TO ADVERTISERS

Columbia-Geneva Div., U. S. Steel Corp. 60, 98-99
Comar Electric Co. 424
Cone-Drive Gears Div., Michigan Tool Co. 278
Continental Diamond Fibre Co., Div. of the Budd Co. 280
Continental Felt Co. 408
Continental Screw Co. 227
Coors Porcelain Co. ..... 273A & B
Copperweld Steel Co., Ohio Seamless Tube Div. 288
Corning Glass Works 263
Cornish Wire Co., Inc. 276
Cramer Posture Chair Co., Inc. 334
Crane Packing Co. 257
Crucible Steel Co. of America 245
Cullman Wheel Co. 408
Cuno Engineering Corp., Super Auto Klean Div. 350
Curtis Universal Joint Co., Inc. 234

D

Dana Corp. 315
Danielson Mfg. Co. 391
Darling Valve & Mfg. Co. 441
Dean Products, Inc., Dean Thermo-Panel Coil Div. 408
DeLaval Steam Turbine Co. 59
Detrex Chemical Industries, Inc. 371
Diamond Mfg. Co. 378
Dodge Mfg. Corp. 360-361
Doehler-Jarvis Div., National Lead Co. 250-251
Douglas Aircraft Co., Inc. 382
Dow Chemical Co. 86, 124
Dow Corning Corp. 239-240
Driv-Lok Pin Co. 404
Dudek & Bock Spring Mfg. Co. 370
Duff-Norton Co. 286
du Pont de Nemours & Co. (Inc.). E. I., Elastomers Div. 225
du Pont de Nemours & Co. (Inc.). E. I., Polychemicals Dept. 90-91
Durakool, Inc. 411
Durametallic Corp. 396
Durez Plastics Div., Hooker Electrochemicals Co. 266

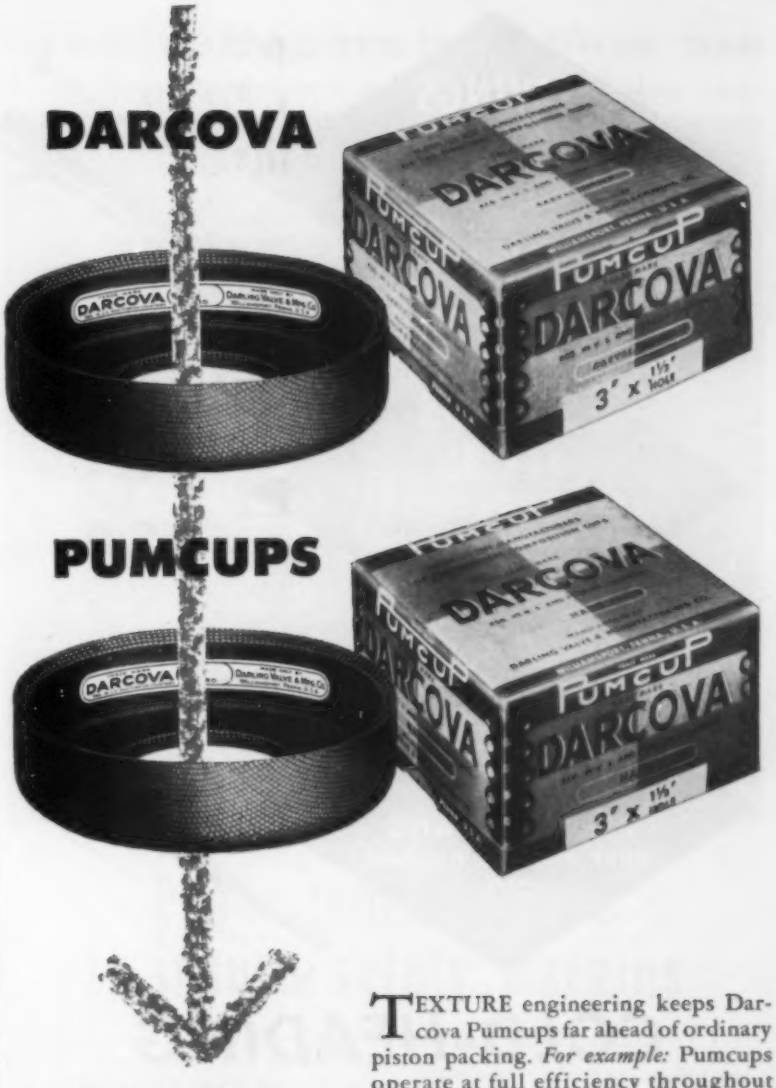
E

Eagle Signal Corp. 387
Eastern Industries, Inc. 436
Eaton Mfg. Co., Foundry Div. 287
Elastic Stop Nut Corp. of America 87
Elco Tool & Screw Corp. 386
Electric Auto-Lite Co., Wire & Cable Div. 249
Electric Steel Foundry Co. 383
Electro Dynamics Div., General Dynamics Corp. 364
Electro Metallurgical Co., Div., Union Carbide & Carbon Corp. 113
Electro Switch Corp. 438
Enjay Co., Inc. 16
Erie Resistor Corp., Electro-Mechanical Div. 252
Euclid Electric & Mfg. Co. 414

F

Fafnir Bearing Co. 229
Fairbanks, Morse & Co., Industrial Div. 214
Falcon Machine & Tool Co., Inc. 422
Farrel-Birmingham Co., Inc. 293
Farval Corp. 128
Faultless Caster Corp. 357
Federal Die Casting Co. 411
Federal Mogul Div., Federal-Mogul-Bower Bearings, Inc. 356
Felters Co. 294
Fenwal, Inc. 14
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 64
Flexonics Corp. 295
Flour City Brush Co. 420
Foote Bros. Gear & Machine Corp. 272
Foote Gear Works, Inc., Brad 244
Ford Motor Co., Industrial Engine Dept. 446
Formed Steel Tube Institute 69
Formsprag Co. 318

(Continued on P. 442)



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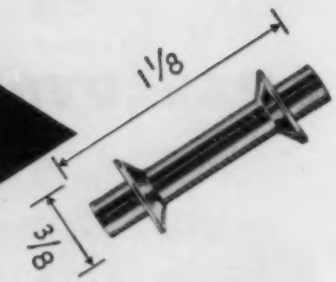

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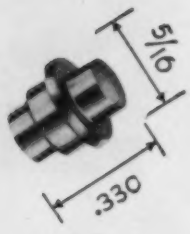

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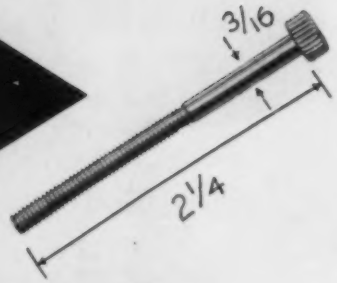

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INDEX TO ADVERTISERS

(Continued from P. 441)

Foster Mfg. Co., Inc. 402
Fostoria Pressed Steel Corp. 416
Frenchtown Porcelain Co. 402
Friez Instruments Div., Bendix Aviation Corp. 444
Fulton Syphon Div., Robertshaw-Fulton Controls Co. ... 331

G

Galland-Henning Nopak Div. 333
Garlock Packing Co. 41
Gates Rubber Co. 332
General Aniline & Film Corp., Ozalid Div. 314
General Dynamics Corp., Electro Dynamics Div. 364
General Electric Co., Apparatus Dept. 399
General Industries Co. 379
General Plate Div., Metals & Controls Corp. 31
Gits Bros. Mfg. Co. 253
Goodrich Co., B. F. 45
Grayhill, Inc. 400
Great Lakes Steel Corp., Div., National Steel Corp. 28-29
Greene, Tweed & Co. 404
Gries Reproducer Corp. 310
Grip Nut Co. 414

H

Handy & Harman 372
Hannifin Corp. 285
Hart Mfg. Co. 374
Harvey Aluminum Sales, Inc. 321
Hassall, Inc., John 442
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 36
Heim Co. 56
Henrite Products Corp. 406
Heyman Mfg. Co. 427
Hilliard Corp. 389
Hoffman Engrg. Corp. 342
Holtzer-Cabot Div. of Nat'l Pneumatic Co., Inc. 417
Horsburgh & Scott Co. 435
Hotwatt, Inc. 415
Houghton & Co., E. F. 84-85
Howell Electric Motors Co. 313
Huck Mfg. Co. 418
Hyatt Bearings Div., General Motors Corp. 26-27

I

Imperial Tracing Cloth 418
Indium Corp. 279
Industrial Metal Protectives, Inc. 298
Industrial Retaining Ring Co. 423
Industrial Tectonics, Inc. 320
Industrial Timer Corp. 118
Ingersoll-Rand Co. 343
Instrument Specialties Co., Inc. 425
International Nickel Co., Inc. 104

J

Jarvis & Jarvis, Inc. 388
Johnson Rubber Co. 412
Jones & Laughlin Steel Corp. 301

K

Kaiser Aluminum & Chemical Corp. 107-108
Kaydon Engineering Corp. 223
Keuffel & Esser Co. 248
Kilian Mfg. Corp. 412
Koppers Co., Inc., Piston Rings & Seal Dept. 337
Kraissl Co., Inc. 380

L

Laminated Shim Co., Inc. 264
LaSalle Steel Co. 13
Leiman Brothers, Inc. 420

INDEX TO ADVERTISERS

Leland, Inc., G. H. 419
Lepel High Frequency Labs., Inc. 413
Lewellen Mfg. Co. 403
Licon Div., Illinois Tool Works 281
Lincoln Electric Co. 269
Linear, Inc. 297
Link-Belt Co. 15, 53, 105
Little Falls Alloys, Inc. 404
Lockheed Aircraft Corp. 393
Long Mfg. Div., Borg-Warner Corp. 242
Lord Mfg. Co. 327

M

McGill Mfg. Co., Inc. 219
MB Mfg. Co., Inc. 405
MacLean-Fogg Lock Nut Co. 394
Magnesium Co. of America 414
Makepeace Co., D. E., Div., Union Plate & Wire Co. 394
Malleable Founders' Society 409
Mallory & Co., Inc., P. R. 8, 120
Mallory-Sharon Titanium Corp. 317
Manheim Mfg. & Belting Co. 236
Marbon Chemical Div., Borg-Warner Corp. 126
Marman Div., Aeroquip Corp. 424
Marvel Engineering Co. 241
Master Electric Co. ..... 3rd Cover
Matthews & Co., James H. 423
Mechanical Air Controls, Inc. 246-247
Meehanite Metal Corp. 234-235
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Metals Disintegrating Co. 390
Metal & Thermit Corp. 284
Metallurgical Products Dept., General Electric Co. 88-89
Meyercord Co., Name Plate Div. 427
Michigan Tool Co., Cone-Drive Gears Div. 278
Miller Fluid Power Div., Flick-Reedy Corp. 121
Milsco Mfg. Co. 410
Minneapolis Honeywell Regulator Co., Industrial Div. 256
Minnesota Mining & Mfg. Co. 46-47
Moraine Products Div., General Motors Corp. 119
Morganite, Inc. 433
Mosinee Paper Mills Co. 443
Mt. Vernon Die Casting Corp. 335
Mueller Brass Co. 114-115

N

National Acme Co. 95
National Aniline Div., Allied Chemical & Dye Corp. 363
National Machine Products Co. 400
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 417
National Screw & Mfg. Co. 274
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 72
National-Standard Co. 122
National Tube Div., U. S. Steel Corp. 60, 65, 98-99
National Vulcanized Fibre Co. 325
Nelson Stud Welding 396-397
Newark Wire Cloth Co. 439
New Departure Div., General Motors Corp. 134
New Hampshire Ball Bearings, Inc. 300
Ney Co., J. M. 420
Nicholson & Co., W. H. 58
Norgren Co., C. A. 305

O

Ohio Seamless Tube Div. of Copperweld Steel Co. 288
Onan & Sons, Inc., D. W. 434
O'Neil-Irwin Mfg. Co. 415

P

Packard Electric Div., General Motors Corp. 109
Paramount Die Casting Co. 417

(Continued on P. 444)

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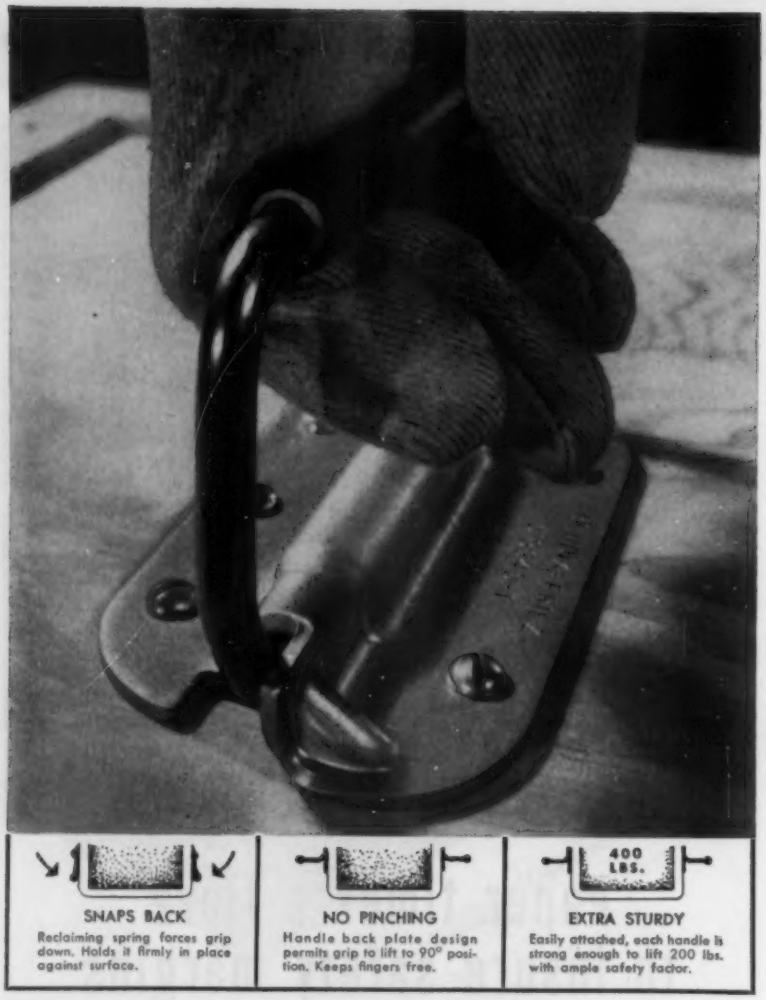

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INDEX TO ADVERTISERS

(Continued from P. 443)

Parker Appliance Co. 283
Parker-Kalon Div., General American Transportation Corp. 35
Parker Rust Proof Co. 330
Parker White Metal Co. 289
Penn Metal Co., Inc. 326
Perfection Gear Co., American Stock Gear Div. 426
Perkins Machine & Gear Co. 290
Philadelphia Gear Works, Inc. 94
Potter Brumfield Mfg. Co., Div., American Machine & Foundry Co. .. 44
Precision Metalsmiths, Inc. 376
Prestole Corp. 282
Price Corp., D. W. 410

R

Reeves Div., Reliance Electric & Engrg. Co. 385
Reeves Instrument Corp., Subs., Dynamatic Corp. of America 386
Rem-Cru Titanium, Inc. 352
Republic Mfg. Co. 418
Republic Steel Corp. 24-25
Reuland Electric Co. 265
Revere Copper & Brass, Inc. 2
Reynolds Metals Co., Parts Div. 50-51
Rhodes, Inc., M. H. 406
Richardson Co. 258
Riverside-Alloy Div., H. K. Porter Co., Inc. 407
Robertshaw-Fulton Controls Co., Aeronautical Div., ... 425
Rochester Products Div., General Motors Corp. 79
Rockford Clutch Div., Borg-Warner Corp. 354
Rotron Mfg. Co., Inc. 340
Rubatex Div., Great American Industries, Inc. 262
Ruthman Machinery Co. 413

S

SKF Industries, Inc. 212
Saginaw Steering Gear Div., General Motors Corp. 37
Sanborn Co. 359
Sandsteel Spring Div., Sandvik Steel, Inc. 402
Schrader's Son A., Div. Scovill Mfg. Co. 369
Sciaky Brothers, Inc. 304
Scintilla Electrical Conn. Div., Bendix Aviation Corp. 370
Shamban & Co., W. S. 406
Shell Oil Co. 106
Shenango Furnace Co., Centrifugally Cast Products Div. 260
Sier-Bath Gear & Pump Co., Inc., Gear Div. 238
Simmons Fastener Corp. 112
Sinko Mfg. & Tool Co. 390
Skinner Electric Valve Div., Skinner Chuck Co. 117
Smith Bearing Co. 410
Smith Corp., A. O., Electric Motor Div. 22-23
South Chester Corp., Southco Div. ... 243
Spencer Thermostat Div., Metals & Controls Corp. 30
Spirold Gear Div., Illinois Tool Works 111
Square D Co. 76-77
Stackpole Carbon Co. 302
Stalwart Rubber Co. 422
Standard Pressed Steel Co. ... 52, 80, 100
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 231
Stephens-Adamson Mfg. Co., Seal-Master Bearings Div. 349
Stevens Mfg. Co., Inc. 11
Stewart Warner Corp. (Alemite) ... 123
Stewart Die Casting Div., Stewart Warner Corp. 81
Stow Mfg. Co. 401
Stratoflo Products, Inc. 413
Streeter-Amet Co. 390
Sturtevant Co., P. A. 422
Superior Carbon Products, Inc. 445

INDEX TO ADVERTISERS

Sweet's Catalog Service.....18-19
Sylvania Electric Products, Inc., Parts Div. 339

T

Taylor Fibre Co..... 78
Tennessee Coal & Iron Div., U. S. Steel Corp. 60, 98-99
Thermoid Co. 395
Thompson-Bremer & Co., Subs. of American Machine & Foundry Co.. 384
Timken-Detroit Brake Co., Rockwell Spring & Axle Co..... 259
Timken Roller Bearing Co..... 82
Tinnerman Products, Inc..... 132
Tomkins-Johnson Co. 311
Torrington Co. 70
Tourek Mfg. Co., J. J..... 273
Townsend Co. 336
Trombetta Solenoids Corp..... 386
Tru-Seal Div., Flick-Reedy Corp.... 416
Tuthill Pump Co..... 67
Twin Disc Clutch Co..... 110

U

Union Carbide & Carbon Co.
Bakelite Co. 38-39
Electro Metallurgical Co..... 113
Haynes Stellite Co..... 36
United-Carr Fastener Corp..... 233
U. S. Gasket Co. 275
U. S. Graphite Co., Div. of the Wickes Corp. .....4th Cover
U. S. Rubber Co., Mechanical Goods Div. 32, 66
U. S. Rubber Co., Naugatuck Chemicals Div. 49
U. S. Steel Corp. 60, 98-99
U. S. Steel Export Co.....60, 98-99
U. S. Steel Supply Div., U. S. Steel Corp. 60, 98-99
United Wire & Supply Corp..... 365
University of California Radiation Laboratory 392

V

Veeder-Root, Inc. 17
Versa Products Co., Inc..... 366
Vickers, Inc., Div. of Sperry-Rand Corp. 277, 345
Viking Pump Co..... 397
Virginia Gear & Machine Corp..... 94
Vulcan Electric Co..... 421

W

Wagner Electric Corp.....42-43
Waldes-Kohinoor, Inc. 61
Wall Colmonoy Corp..... 416
Ward Leonard Electric Co..... 373
Washington Steel Corp..... 296
Webster Electric Co., Oil Hydraulics Div. 71
Weckesser Co. 376
Weirton Steel Co., Div., National Steel Corp. 57
Westinghouse Electric Corp. 48, 62-63, 83, 92
West Virginia Works, Connors Steel Div., H. K. Porter, Inc..... 309
White Mfg. Co., S. S..... 338
Whitney Chain Co..... 116
Wiegand Co., Edwin L..... 384
Willys Motors, Inc., Industrial Engine Sales Dept. 68
Wilson Co., H. A..... 347
World Bestos Div., Firestone Tire & Rubber Co. 377

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EMPLOYMENT OPPORTUNITIES..428-431
BUSINESS OPPORTUNITIES (OFFERED) 432

Index to Advertisers begins on P 440
Products Index begins on P 433

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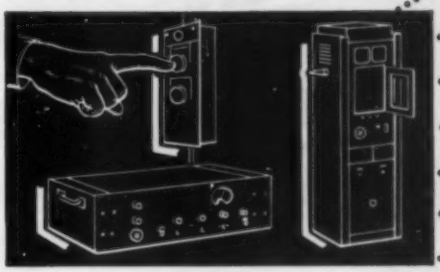

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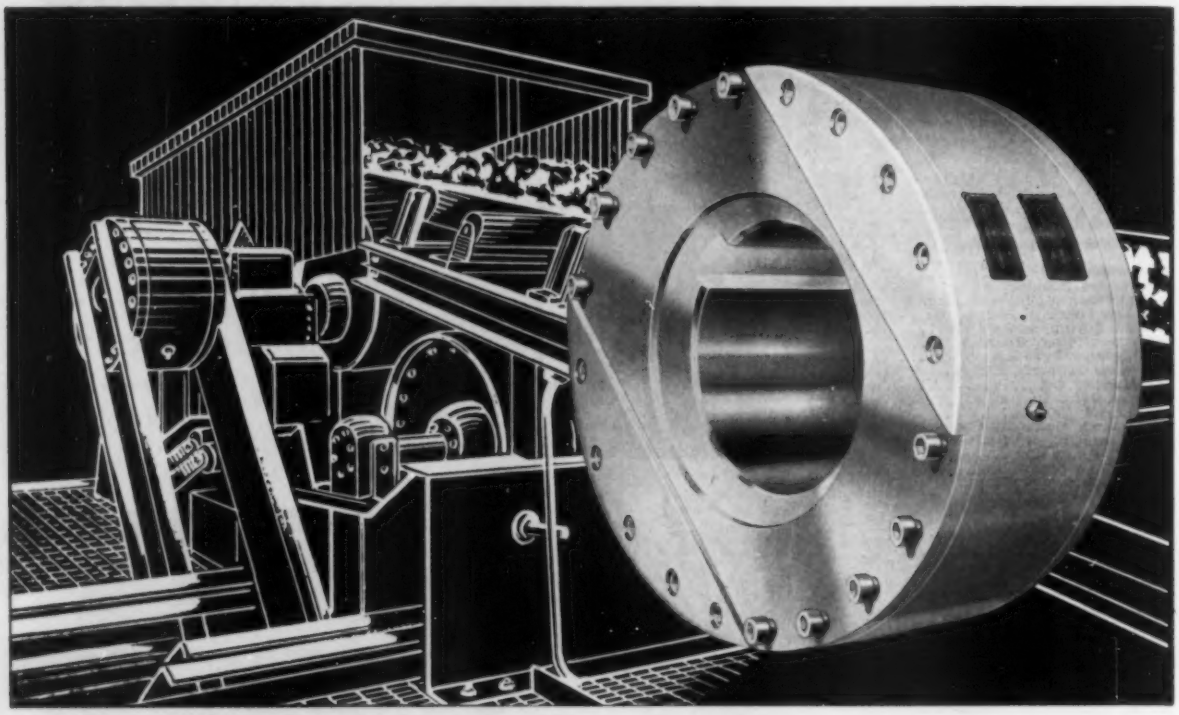

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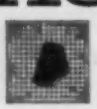

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37—Coaxial Cable
38—Collet-Fitting Knob
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58—Acceleration and Speed Controller
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61—Circuit-Breaking Receptacles
62—Motor-Pump Unit
63—Variable Permence Transducer
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70—Line Voltage Regulator
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C2	1	2	4	6	8	11	13	14	15	16	17	18-9	20-1
22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38-9	40	41
42-3	44	45	46-7	48	49	50-1	52	53	54-5	56	57	58	59
60	61	62-3	64	65	66	67	67a-b	68	69	70	71	72	73
74	75	76-7	78	79	80	81	82	83	84-5	86	87	88-9	90-1
92	93	94	95	96-7	98-9	100	101-2	103	104	105	106	107-8	109
110	111	112	113	114-5	116	117	118	119	120	121	122	123	124
125	126	127	128	130	132	134	210	212	214	219	221	223	225
227	229	231	233	L234	R234	235	236	237	238	239-40	242	243	244
245	246	L247	R247	248	249	250-1	252	253	254-5	257	258	259	260
261	262	263	264	265	266	267	268	269	270-1	272	273	273a-b	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302
303	304	305	306	307-8	309	310	311	312	313	314	315	316	317
318	319	320	321	322	323	324	325	326	327	328	329	330	331
332	333	L334	R334	335	336	337	338	339	340	341	342	343	344
345	346	347	348	349	350	351	352	353	354	355	356	357	358
359	360	361	362	363	364	365	366	367	368	369	T370	BL370	BR370
371	372	373	374	375	L376	TR376	377	378	379	380	381	383	L384
R384	385	L386	TR386	BR386	387	T388	389	L390	TR390	BR390	391	L394	TR394
BR394	395	TL396	B396	TR397	B397	398	399	L400	TR400	BR400	401	L402	TR402
BR402	403	L404	TR404	BR404	405	L406	TR406	BR406	407	L408	TR408	BR408	409
L410	TR410	BR410	TR411	BR411	T412	BL412	BR412	TR413	BC413	BR413	L414	TR414	BR414
L415	R415	L416	TR416	BR416	L417	R417	L418	TR418	BR418	419	L420	TR420	BR420
L421	R421	L422	TR422	BR422	L423	R423	L424	TR424	BR424	TR425	L426	L427	R427
433	434	435	436	437	438	439	440	441	442	443	444	445	446
C3	C4												

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119							

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS IN THIS ISSUE

120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167	168	169	170	171	172	173	174	175
176													

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22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38-9	40	41
42-3	44	45	46-7	48	49	50-1	52	53	54-5	56	57	58	59
60	61	62-3	64	65	66	67	67a-b	68	69	70	71	72	73
74	75	76-7	78	79	80	81	82	83	84-5	86	87	88-9	90-1
92	93	94	95	96-7	98-9	100	101-2	103	104	105	106	107-8	109
110	111	112	113	114-5	116	117	118	119	120	121	122	123	124
125	126	127	128	130	132	134	210	212	214	219	221	223	225
227	229	231	233	L234	R234	235	236	237	238	239-40	242	243	244
245	246	L247	R247	248	249	250-1	252	253	254-5	257	258	259	260
261	262	263	264	265	266	267	268	269	270-1	272	273	273a-b	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302
303	304	305	306	307-8	309	310	311	312	313	314	315	316	317
318	319	320	321	322	323	324	325	326	327	328	329	330	331
332	333	L334	R334	335	336	337	338	339	340	341	342	343	344
345	346	347	348	349	350	351	352	353	354	355	356	357	358
359	360	361	362	363	364	365	366	367	368	369	T370	BL370	BR370
371	372	373	374	375	L376	TR376	377	378	379	380	381	383	L384
R384	385	L386	TR386	BR386	387	T388	389	L390	TR390	BR390	391	L394	TR394
BR394	395	TL396	B396	TR397	B397	398	399	L400	TR400	BR400	401	L402	TR402
BR402	403	L404	TR404	BR404	405	L406	TR406	BR406	407	L408	TR408	BR408	409
L410	TR410	BR410	TR411	BR411	T412	BL412	BR412	TR413	BC413	BR413	L414	TR414	BR414
L415	R415	L416	TR416	BR416	L417	R417	L418	TR418	BR418	419	L420	TR420	BR420
L421	R421	L422	TR422	BR422	L423	R423	L424	TR424	BR424	TR425	L426	L427	R427
433	434	435	436	437	438	439	440	441	442	443	444	445	446
C3	C4												

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1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119							

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120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167	168	169	170	171	172	173	174	175
176													

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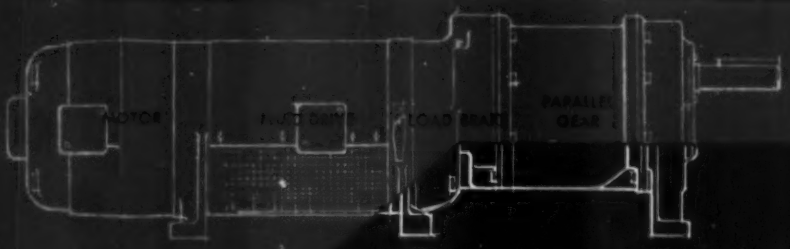

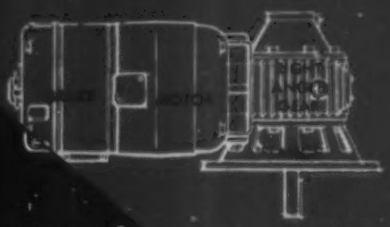

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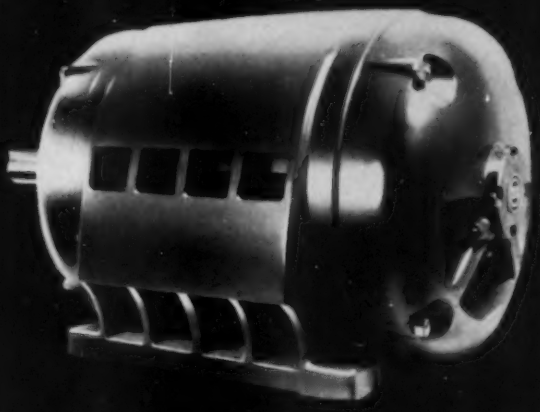

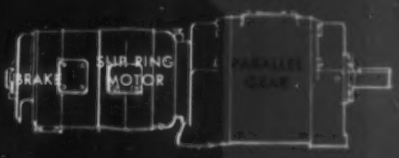

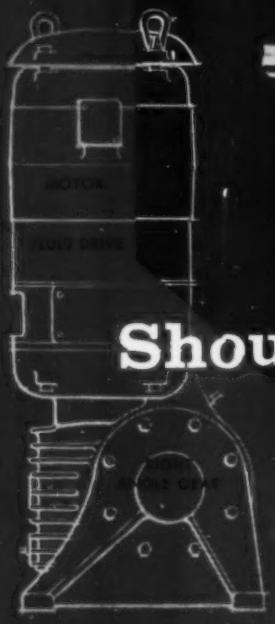

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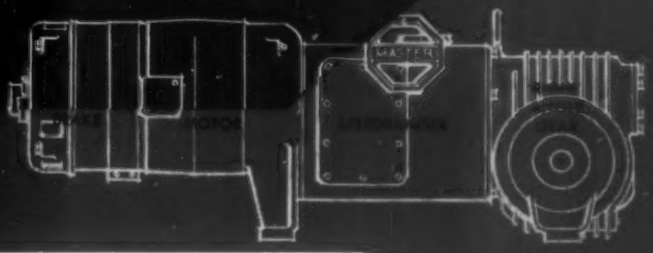

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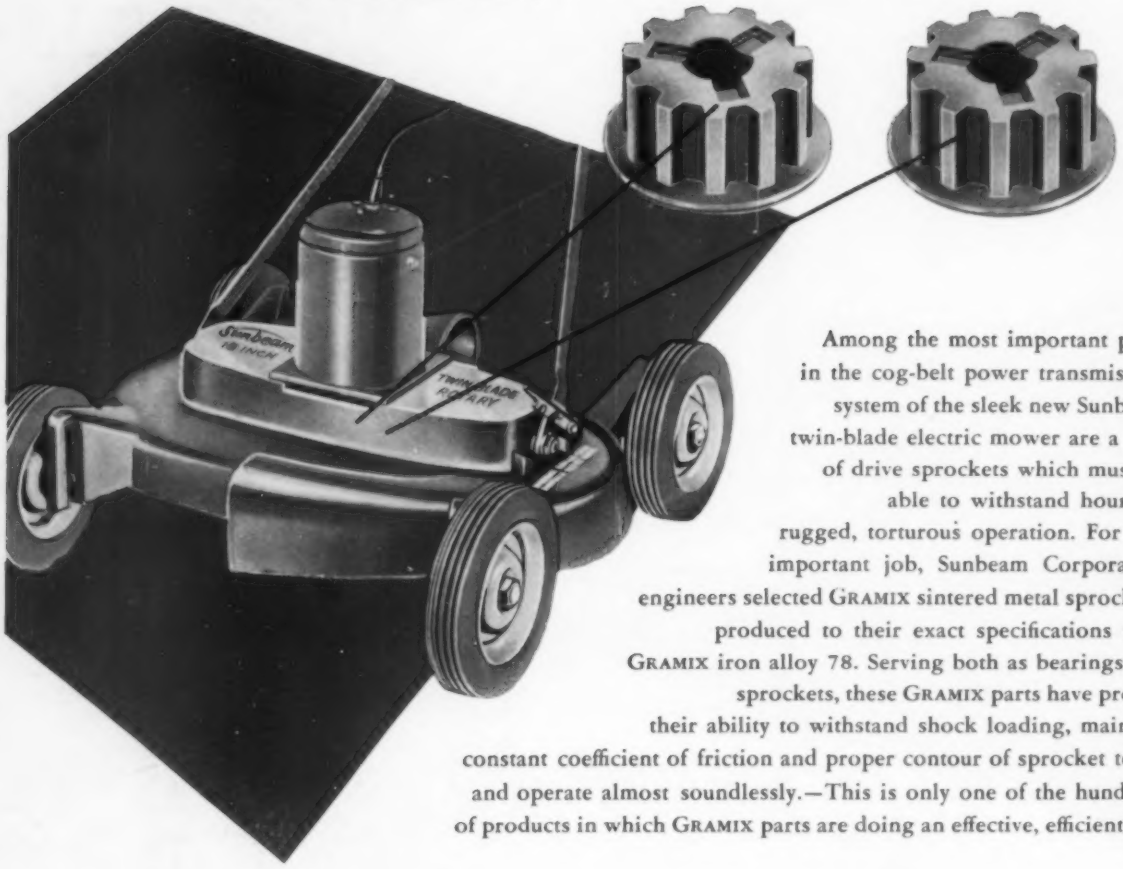

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